YOUTH ASTRONOMY & SPACE SCIENCE CONGRESS

YASSC 2026

Guide Book

Organised by

TAMILNADU ASTRONOMY AND SCIENCE SOCIETY- TASS

In association with

Guide Book

CONTENTS

Page	Topics
03	About TASS
04	About YASSC 2026
06	State Advisory Committee
07	State Academic Committee
08	State Organising Committee
09	Details of Regions
12	General Rules and Guidelines
14	Dates for Regional and State level YASSC 2026
15	Specific Guidelines for Paper Presentation
19	Specific Guidelines for Poster Presentation
23	Specific Guidelines for Astro Short Film Making
25	Specific Guidelines for Astro-Photography
27	Specific Guidelines for Development of Innovative Space Related Games
29	Appendix 1 -Model Paper Presentations
66	Appendix 2 -Model Poster Presentations
69	Appendix 3 -More Information of Focal Theme and Sub-Themes

TAMILNADU ASTRONOMY AND SCIENCE SOCIETY- TASS

The Tamil Nadu Astronomy & Science Society (TASS) serves as an umbrella organization for various Astronomy clubs across Tamil Nadu. Established in 2021, TASS comprises several units, including the Kovai Astro Club, Trichy Astro Club, Chennai Astro Club, Salem Astro Club, and Madurai Astro Club, among others.

The primary objective of TASS and its affiliated Astro Clubs are to foster a scientific temper among the public, particularly targeting school and college students, through the medium of Astronomy.

TASS has successfully conducted numerous public outreach programs throughout Tamil Nadu, with signature events such as the Star Party, Moon Festival, "1000 Idangalil Astronomy," Planet Festival 2024, Astronomy in 5000 places, Scope Festival 200, Astronomy Lab in 1000 places and Spectrum Festival.

Through its initiatives, TASS has promoted the astronomy in over 3,000 locations, spanning from rural villages to metropolitan areas, including Illam Thedi Kalvi centers and universities, ultimately reaching more than 5,00,000 individuals, including students.

The TASS emphasizes Astronomy education, facilitated by a dedicated group of volunteers, which includes students, teachers, professors, scientists, and astronomy enthusiasts.

We invite you to join your local District Astro Club and participate as a volunteer in any area of your interest.

Youth Astronomy and Space Science Congress
YASSC - 2026

The most striking feature of Astronomy is that it is the origin of all sciences and it plays a crucial role in developing interest across various branches of Science. It enhances the scientific skills and performance of the students.

YASSC 2026, the Youth Astronomy and Space Science Congress, is designed to provide a forum for Undergraduate students to showcase their creativity and innovation through scientific methods.

YASSC -2026 is a State Level Congress featuring invited talks on history and achievements in Space Science by eminent scientists, researchers and science communicators from prestigious National and International Institutions.

YASSC aims to offer diverse scientific forums, allowing students to expand their knowledge and research aptitude in astronomy, space science, and recent advancements in space technology. YASSC would enable the opportunities for students to exhibit their skills through:

Paper/Poster presentations
Astro-Short Film Making
Astro Photography
Development of Innovative Space Related Games

YASSC-2026 will be conducted at Regional and State levels. Outstanding projects selected at the Regional level will advance to the State-level Congress, where students will gain broader exposure and recognition.

Registration Opens :	**01.06.2026**
Registration Closes :	**07.07.2026**
Orientation Workshop -1 (Online) :	**11.07.2026**
Orientation Workshop -2 (Online) :	**14.07.2026:**
Orientation Workshop -3 (Online) :	**15.07. 2026**
Last Date for Project Submission (Regional) :	**07.08.2026**
Regional Level Congress :	**last week of August, 2026**
State level Congress :	**02.10.2026 to 04.10.2026**

Regions

Chennai, Coimbatore, Madurai, Salem, Sivaganga, Thanjavur, Tiruchirappalli, Tirunelveli, Tirupattur, Tiruvannamalai

The Venue and Date for the Regional level Congress will be announced through email after registration

State Congress will be held at Coimbatore

02.10.2026 to 04.10.2026

The Venue for the State level Congress will be announced through email after registration

*** Subject to Changes**

Youth Astronomy and Space Science Congress YASSC-2026 will cover topics in Astronomy and Space Science as per the Focal Theme and Sub themes as listed below

Focal Theme

The New Space Age:
Bridging Science, Technology & Society

Sub-Themes

1. Our Cosmic Neighbourhood
The Solar System: Exploration & Discoveries (2010 –present)

2. A. Stellar Physics (2010 – present)
B. High-Energy Astrophysical Events (2010 – present)

3. Exoplanets & the Science of Habitability
(1992 – present)

4. Emerging Space Technologies & Indigenous Launch Capabilities
(2010 – present)

5. Mathematical Modelling & Computational Tools in Astronomical Research (2010 – present)

6. Astronomy Education, itizen Science & Science Communication in India

Undergraduate College Students of Engineering, Arts and Science, Commerce, Management, Agriculture, Law, and Medicine, who are interested in Astronomy and Space Science and Technology can participate.

To register and to view Guide Book please visit:

https://tass.co.in/yassc-2026

1. **Before registering, go through the Guide Book which is in the above web address.**
2. **One can attend not more than two events.**
3. **Seperate registration is required for each event.**

No Registration Fee.

Advisory committee for YASSC-2026

Dr. Mylsamy Annadurai,
Project Director, Chandrayan 1 & 2 & Mangalyan.
Former Director, Indian Space Research Organisation (ISRO).

Dr. S.Vincent,
Member Secretary,
Tamilnadu State Council for Science and Technology.

Dr. Niger Shaji,
Former Director, Aditya L1, ISRO.

Dr. Nakul Parashar,
Senior Advisor, Sri Kaleeswari College.
CEO, Shanthi Foundation Global.

Dr. Niruj Mohan Ramanujam,
Head,SCOPE, Indian Institute of Astrophysics, Bengaluru.

Dr. R. Ramanujam,
Professor IMSc.(Rtd.), Chennai.

Dr. Manjari Bagchi,
Professor, IMSc, Chennai

Dr. T.V. Venkateshwaran,
Visiting Professor, IISER, Mohali.

Dr. Surhud S. More,
Professor, IUCAA, Pune.

Dr. Jasjeet Singh Bagla,
Department of Physical Sciences, IISER, Mohali.

Er. V. Rajasekar,
Senior Scientist, VSSC, ISRO, Thiruvananthapuram.

Dr. T.R. Govindarajan,
Professor IMSc, (Rtd.) KREA University, Sri City, Andhra.

Er. Paranthaman Subramaniam,
Deputy General Manager, TTI & RC, TANGEDCO-TNEB

Dr. S. Boopathi,
Scientist, Department of Biotechnology, IIT-Madras.

Dr. Balaji Sampath,
Founder, Aha Guru, Chennai.

Ayeesha Era. Natarasan,
Science Writer, Bal Sahitya Puraskar Awardee.

Dr. Rajendren,
Vice Chancellor, AMET University, Chennai.

Dr. J. Princy Merlin,
Principal, Bishop Heber College, Tiruchirappalli.

Dr. A.T. Ravichandran,
President, Raman Reasearch Foundation, Tiruchirappalli.

Dr. R. Samson Ravindren,
Executive Director, Mahendra Group of Institutions, Salem.

Mr B. Srikumar,
State Co-ordinator, Ariviyal Palagai.

Academic Committee for YASSC-2026

Dr. D. Khanna.
State Academic Coordinator YASSC 2026 -90807 76415
Academic Coordinator of Kovai Astro Club,
Assistant Professor, Karunya Institute of Technology and Sciences, Coimbatore.

Dr.A.Josephine Prabha
Associate Dean of Sciences, Bishop Heber College, Tiruchirappalli,
Advisor,Trichy Astro Club and Academic Coordinator .

Dr. M. Chrisphin Karthick
Scientist, Deputy Head, SCOPE, IIA, Bengaluru.

Mr. Samir Dhurde
Scientific Officer - Public Outreach, IUCAA, Pune.

Dr.P.Sasikumar
Scientist/Engineer, Vikram Sarabhai Space Centre,(VSSC), Thiruvananthapuram.

Dr.V. Madhurima
Professor, Department of Physics, Central University of Tamil Nadu, Tiruvarur.

Prof.K.Sakthivel
Professor (Rtd.), Department of Physics, PSG Tech, Coimbatore,
Advisor, Kovai Astro Club, General Council Member,TASS.

Dr. Natarajan Shriethar
Head, R&D Department, MaGa Techgramam, Karaikudi.

Dr.R.V. Krishnakumar
Associate Professor of Physics,Thiagarajar college, Madurai.

Dr.M. Karunakaran
Associate Professor of Physics, Alagappa Govt. Arts College, Karaikudi.

Thiru. M. Srinivasanran
Project Director, Science & Tinkering, AID INDIA, Chennai.

Dr. Priya Hasan
Assistant Professor, Maulana Azad National Urdu University, Hyderabad,India.

Mr.B.M. Muhilan
Citizen Scientist, TASS, Trichy.

YASSC State Organising Committee

State Organising Committee -YASSC 2026

Thiru. G. Ramesh, State President
Thiru. J.Manohar, General Secretary
Mrs. D. Mekala, Treasurer
Thiru SP. Sellakumar, State Coordinator- YASSC 2026. 91761 75191
Thiru. S. Balagurunathan, Vice President
Thiru S. Sakthivel, Vice President
Mrs. T. Santhi, Secretary
Dr. P. Ramesh, Documentation Coordinator- YASSC 2026.
Mrs. C. Cinthia, Secretary
Mrs. R. Nithya, Secretary
Thiru. M. Andiraj, State Coordinator, IT Wing
Thiru. Udhayan @ Palaniandi. D. Former State Coordinator YASSC 2025

YOUTH ASTRONOMY & SPACE SCIENCE CONGRESS

YASSC 2026

Organised by

TAMILNADU ASTRONOMY AND SCIENCE SOCIETY- TASS

In association with

The Institute of Mathematical Sciences - IMSc Chennai
(A National Institute for Research in the Theoretical Sciences)

Indian Institute of Astrophysics - IIA Bengaluru
(An Autonomous Institution under the Dept. of Science & Technology, Govt. of India)

Tamil Nadu State Council for Science and Technology - TNSCST
(An Autonomous Body under the Dept. of Higher Education, Government of Tamil Nadu)

AID INDIA
Raman Research Foundation - RRF
Ariviyal Palagai

Details of the Regions.

Regions	Districts in the region	The District which hosts and conducts Regional Congress & Regional Coordinators
01 Chennai	Chennai - North, Chennai – South , Tiruvallur, Kanchipuram, Chengalpattu	Chennai North M. Jagadeeswaran - 91501 33336
02 Coimbatore	Coimbatore, Nilgiris, Erode, Tiruppur	Coimbatore R.S. Pradeep - 98945 25559
03 Madurai	Madurai, Virudhunagar, Dindigul, Theni	Madurai C. Cinthia - 75980 27070
04 Salem	Salem, Namakkal, Dharmapuri, Krishnagiri	Krishnagiri N. Sureshkumar - 8838102932
05 Sivaganga	Sivaganga, Ramanathapuram Pudukkottai	Sivaganga T. Chokkanathan - 89035 29435
06 Thanjavur	Thanjavur, Tiruvarur, Nagapattinam, Mayiladuthurai	Thanjavur S. Balagurunathan - 9965952057
07 Tiruchirappalli	Tiruchirappalli, Karur, Perambalur, Ariyalur	Tiruchirappalli T. Santhi - 94888 09748
08 Tirunelveli	Tirunelveli, Thoothukudi Tenkasi, Kanyakumari	Tirunelveli Dr. V. Muthusamy - 9994368567
09 Tirupattur	Tirupattur,Vellore, Ranipet	Tirupattur R. Nithya - 99947 41633
10 Tiruvannamalai	Tiruvannamalai,Kallakurichi Viluppuram, Cuddalore	Tiruvannamalai M. Srinivasan - 98401 73823

Please note:

The venue and date of the Regional Congress will be intimated to the participants by the concern Regional Coordinators.

Participants of YASSC 2026 may contact their respective Regional Coordinators for clarification regarding any doubts about regional level YASSC 2026. Regional coordinator's detail will be sent through email.

State Level Congress

Place : Coimbatore

Venue : Detail will be informed through email.

Date : 02.10.2026, 03.10.2026 and 04.10.2026

Guidelines

(Rules, Regulations, Do's and Don'ts)

Events

- Paper/Poster presentations
- Astro-Short Film Making
- Astro Photography
- Development of Innovative Space Related Games

General Rules and Code of Conduct (Applicable to All Events)

Eligibility:

- Participants must be college students (Undergraduate) studying in recognized colleges/universities in the state of Tamil Nadu.

Registration:

- All participants must register through the official online portal by the specified last date: 07.07.2026
- **Registration Link:** **https://tass.co.in/yassc-2026**
- Participants can register as a team of two members for an event. However, for astrophotography and development of innovative space related games, participants can also register as a single person or a group of two members.
- For each event, a separate registration must be done.
- A participant can register not more than two events at a time.

Originality & Plagiarism:

- All submissions must be original work of the participants.
- Plagiarism in any form will lead to immediate disqualification.
- Plagiarism will be checked by a professional software.
- Proper citation of all sources (references, images, data) is mandatory and should be carried out by APA 7 format.

Language:

All submissions and presentations must be in Tamil/English

Submission Platform:

After registration, a separate email address will be communicated through the registered email. All submissions must be submitted via the designated email addresses at regional level.

Evaluation:

- Decisions of the evaluation panel are final and binding. No appeal will be entertained.
- Evaluation scores and feedback will not be publicly disclosed.

Intellectual Property:

- By participating, contestants grant the Tamilnadu Astronomy and Science Society (TASS) a non-exclusive, royalty-free license to use, reproduce, display, and publish their submitted work for promotional, educational, and archival purposes related to the Youth Astronomy and Space Science Congress and TASS activities.
- Authors/creators retain copyright of their original work.

Certificates:

Selected participants in each category will receive certificates of merit. All participants will receive participation certificate.

Disqualification:

TASS reserves the right to disqualify any participant or team found to be in violation of these rules, engaging in unethical conduct, or attempting to unfairly influence the competition.

Themes of YASSC 2026

All submissions must strictly adhere to the central theme of YASSC 2026 and be categorized under one of the designated sub-themes.

Focal Theme

The New Space Age: Bridging Science, Technology & Society

Sub-themes of YASSC 2026

1. Our Cosmic Neighbourhood – The Solar System: Exploration & Discoveries (2010 –present)
2. A. Stellar Physics (2010 – present)
   B. High-Energy Astrophysical Events (2010 – present)
3. Exoplanets & the Science of Habitability (1992 – present)
4. Emerging Space Technologies & Indigenous Launch Capabilities (2010 – present)
5. Mathematical Modelling & Computational Tools in Astronomical Research (2010 – present)
6. Astronomy Education, Citizen Science & Science Communication in India

*** More details about the sub-themes is given in Appendix-3.**

Orientation programmes

To ensure effective participation and provide clarity for undergraduate students, the Tamil Nadu Astronomy and Science Society (TASS) will host three state-level orientation sessions.

The schedule for these mandatory Orientation programmes are as follows:

July 11, 2026: Comprehensive overview of the Rules and Regulations for YASSC 2026.
July 14, 2026: Detailed introduction to the primary three sub-themes.
July 15, 2026: Detailed introduction to the subsequent three sub-themes.

Furthermore, to foster engagement at the local level, Regional Academic Committees are encouraged to organize regional orientation programs during the third week of July 2026.

After the completion of the regional congress, two specialized orientation programs will be organized in September 2026 for students who have qualified for the State Level YASSC 2026.

Dates for Regional and State level YASSC 2026

The regional congress of YASSC 2026 is scheduled to take place during the final week of August 2026. Specific details regarding the dates and venues for the regional congress will be informed to all participants via their registered email addresses.

The State Level YASSC 2026 will be held at Coimbatore from October 2 to October 4, 2026. The venue for the state congress will be formally announced after the completion of the regional congress through email.

Selection at Regional Level YASSC 2026.

Participants' performance will be assessed in strict accordance with the detailed guidelines established for each event.

Selected students in regional congress must confirm their participation in the State Level YASSC 2026.

Furthermore, exclusive commendations and rewards await those who will be selected in the state-level congress.

In a prestigious collaboration, the Science Communication, Public Outreach, and Education (SCOPE) Section of the Indian Institute of Astrophysics (IIA) will provide guidance to the selected students at the State Level YASSC 2026.

Furthermore, selected participants will benefit from specialized post-congress orientation programs designed to facilitate their entry into elite institutions specializing in astronomy, astrophysics, and space sciences.

Specific Guidelines - 1

Paper Presentation

Paper Presentation

Objective: To encourage original research, literature review papers, statistical analysis, critical analysis, and effective communication of complex ideas in astronomy, astrophysics, cosmology, or space-related technologies as per the sub-themes.

Eligibility: Open to all registered participants.

Members: A group of two students.

Submission Guidelines:

- AAbstract: Submit a concise abstract (max 250 words) outlining the research question, methodology, key findings, and conclusion.
- Abstract Submission: Abstract should be submitted during the registration itself.
- Full Paper: Upon abstract acceptance, submit a full research paper (1500-2500 words, excluding references). The paper must include an Introduction, Literature Review, Methodology, Results/Discussion, Conclusion, and References (APA 7 style preferred).
- Last Date for Full Paper Submission: 28.07.2026.
- Last Date Plagiarism Corrected Resubmission: 14.08.2026.

Selection Guidelines:

- Participants may indicate their preference for either an oral or a poster presentation upon submission. However, the YASSC 2026 Academic Committee reserves the right to reassign oral presentations to the poster presentations with respect to the standard of the presentation.
- The decision of the evaluation committee in this regard is final and binding.

Instructions for Oral Presentation:

- Oral Presentation: Prepare a concise PowerPoint presentation (max 12 slides) for a 7-minute presentation, followed by a 3-minute Q & A session.
- Last Date for PowerPoint Presentation Submission: 21.08.2026.

Evaluation Criteria:

- Originality of the submitted paper
- Scientific accuracy and depth of research
- Quality of written paper (organization, grammar, references)
- Clarity and effectiveness of oral presentation
- Ability to answer questions

- **Plagiarism should be less than 20% with proper citations.**

Paper Presentation : Formatting Rules

To ensure uniformity and a professional presentation befitting a scientific congress, please adhere to the following formatting standards:

Document Setup:

Page Size: A4

Margins: 1 inch (2.54 cm) on all sides (top, bottom, left, and right).

Line Spacing: Double-space throughout the entire paper, including the abstract, body paragraphs, block quotations, tables, figure captions, and references.

Alignment: Left-align the main body text. Full justification.

Font:

Recommended Font: Times New Roman

Font Size (Body Text): 12-point

Consistency: Use the chosen font and size consistently throughout the paper, unless otherwise specified for headings, tables, or figures.

Headings:

Ensure consistent capitalization, bolding, indentation, and alignment for all headings.

Level 1 Heading (e.g., Introduction, Literature Review, Conclusion, References):

Format: Centered, Bold, All Caps (e.g., INTRODUCTION)

Font Size: 12-point

Placement: Placed on its own line, with a double space before and after.

Level 2 Heading (e.g., Theories of Stellar Evolution, Exoplanet Detection Methods):

Format: Flush Left, Bold, Title Case (e.g., Exoplanet Detection Methods)

Font Size: 12-point

Placement: Placed on its own line.

Level 3 Heading (e.g., Transit Photometry, Radial Velocity Method):

Format: Flush Left, Bold, Italicized, Title Case (e.g., Transit Photometry)

Font Size: 12-point

Placement: Placed on its own line.

Abstract Page:

Title: The word "ABSTRACT" (12-point, bold, centered) should appear at the top of the page, on its own line, before the abstract text.

Text: The abstract content should be a single paragraph, not indented, and within the 250-word limit. Use 12-point font.

Keywords:
On the line immediately following the abstract, indent the first line (0.5 inches or 1.27 cm). Type "Keywords:" (italicized, bold), followed by the keywords in lowercase (except for proper nouns), separated by commas. (e.g., Keywords: interstellar travel, space propulsion, Alpha Centauri).

Paragraphs:
Indentation: The first line of every paragraph in the main body text should be indented 0.5 inches (1.27 cm) from the left margin.

Tables and Figures:
Numbering: Number all tables and figures sequentially (e.g., Table 1, Table 2; Figure 1, Figure 2).

Titles/Captions for Tables: Table number (e.g., Table 1) and a brief, descriptive title (e.g., Table 1. Types of Interstellar Propulsion) should appear above the table.
Titles/Captions for Figures: Figure number (e.g., Figure 1) and a brief, descriptive caption (e.g., Figure 1. Artist's impression of a laser-powered lightsail.) should appear below the figure.

Placement: Tables and figures should be placed as close as possible to where they are first mentioned in the text. Mention in the running text without forgetting (e.g., Table 1 gives the types of interstellar propulsion. Figure 1 gives the artist's impression of a laser powered light sail.) Ensure they are clearly readable.

References Page:
Title: The word "REFERENCES" (12-point, bold, centered) should appear at the top of the page, on its own line. Start the REFERENCES in the next page after CONCLUSION.

Format: All entries must adhere strictly to APA 7th edition guidelines. Single Line Space. With 6 pt left below each line.

Indentation: Use a hanging indent for each reference entry (the first line is flush left, and subsequent lines are indented 0.5 inches).

Alphabetical Order: List all references in alphabetical order by the first author's last name.

Page Numbers:
Placement: Place page numbers in the top right-hand corner of every page, starting from the title page.

Plagiarism should be less than 20% with proper citations.

Specific Guidelines - 1

Poster Presentation

Poster Presentation

Objective: To develop skills in visual communication of complex scientific information and research findings as per the sub themes in an engaging and accessible format.

Eligibility: Open to all registered participants.

Members: A group of two persons.

Submission Guidelines:

- Printed Poster: Design a high-resolution poster and take a printout.
- Dimensions: A0 size for optimal detail.
- Minimum resolution: 300 DPI.
- Content: Must include Title, Authors) Affiliation, Introduction, Methods (if applicable), Results, Discussion, Conclusion, and References.
- Presentation: Participants are required to explain their poster and be available for a live Q&A session during a designated presenting period.
- Last date : Submission of Soft Copies of the poster – 21.08.2026

Evaluation Criteria:

- Originality and creativity
- Scientific accuracy and relevance to theme
- Visual appeal and design (clarity, aesthetics, readability)
- Clarity and effectiveness of poster presentation
- Ability to answer questions

Plagiarism should be less than 20% with proper citations.

Poster Formatting Rules

- Poster presentations are a visual medium designed for quick comprehension and to invite discussion.
- A0 poster should be visually engaging, concise, and effectively communicate research.

Overall Poster Dimensions & Orientation:
Size: A0 (841 mm (width) x 1189 mm (length) or 33.1 x 46.8 inches).
Orientation: Vertical (Portrait).
(or)
Size: A0 (1189 mm (width) x 841 mm (length) or 46.8 x 33.1 inches).
Orientation: Horizontal (Landscape).

Layout and Flow:
Visual Flow: Design for a clear visual path, typically starting from the top-left and flowing down columns, then across. A multi-column layout (e.g., 2-4 columns) is highly recommended.
Whitespace: Utilize ample whitespace around text blocks, images, and between columns. This improves readability and reduces visual clutter. Aim for roughly 30-40% of the poster space as whitespace.
Sections: Clearly define sections (e.g., Introduction, Methodology, Results, Conclusion, References, Acknowledgements) with distinct headings. Use borders or background colors sparingly to delineate sections if it aids clarity.

Text Content and Readability:
Conciseness is Key: Avoid dense paragraphs. Use bullet points, numbered lists, and short sentences. Each section should convey only the most critical information.
Font Choice: Use a clear, sans-serif font like Arial, Helvetica, Calibri, or Inter. Sans-serif fonts are generally more readable on large-format prints and at a distance.

Font Sizes (Minimums for A0, read from 1-2 meters):
Title: 80-120 pt (or larger, ensuring it fits) – Prominent, bold, attention-grabbing.
Author(s) & Affiliation(s): 48-60 pt
Section Headings (e.g., INTRODUCTION, METHODS): 36-48 pt – Bold, potentially ALL CAPS.
Body Text (Bullet Points/Short Sentences): 24-36 pt – This is the minimum for easy readability.
Captions (Figures/Tables): 18-24 pt

References/Contact Info: 18-24 pt
Case: Use Title Case or Sentence Case for body text. ALL CAPS should be reserved primarily for main titles and section headings to prevent reader fatigue.
Line Spacing: Ensure adequate line spacing (1.2 to 1.5 times the font size) to prevent text from looking cramped.
Contrast: Use high contrast between text and background colors (e.g., dark text on a light background, or vice-versa). Avoid busy or patterned backgrounds behind text.

Visual Elements (Figures, Graphs, Images):
Dominance: Visuals should occupy approximately 40-50% of the poster space. They are the primary communicators of your findings.

High Resolution: All images, graphs, and logos must be high resolution (at least 300 DPI at print size) to prevent pixelation. Avoid images copied directly from websites unless they are specifically provided in high resolution.

Clarity: Graphs and charts should be clean, well-labeled, and easy to interpret. Use clear legends and axis labels.

Captions: Every figure and table must have a concise, descriptive caption placed directly below it (for figures) or above it (for tables).

Minimal Text on Visuals: If graphs or diagrams have text, ensure it's large enough to read (minimum 18-24 pt if possible).

Title & Author Block:
Title: Placed prominently at the very top. It should be informative yet concise, capturing the essence of your research.

Authors & Affiliations: Clearly list all authors and their institutional affiliations directly below the title.

Branding & Logos:
Include the YASSC logo (if provided) and your institution's logo(s) in a designated, non-intrusive area (e.g., top corners).

References and Contact Information:
References: List only the most crucial 3-5 references directly on the poster in a smaller font size. For a complete list, consider adding a QR code that links to an online version of your paper or a dedicated reference list.

Contact Information: Include clear contact details (e.g., email address, department, QR code to your LinkedIn/research profile) so interested attendees can follow up.

Printing Considerations:
Color Profile: If possible, use CMYK color profile for print-ready files.
File Format: Submit in a high-resolution PDF format.

Specific Guidelines - 2

Astro Short Film Making

Astro Short Film Making

Objective:
To encourage storytelling, creativity, and visual artistry in conveying themes related to astronomy, astrophysics, cosmology, or space exploration as per the sub-themes.

Eligibility: Open to all registered participants.

Members: A group of two persons.

Submission Guidelines:

- Theme: Must be directly related to astronomy, astrophysics, cosmology, or space technology. Can be a story of a scientist, a discovery, a technology, an astronomical object description or a phenomenon.
- Duration: Minimum 5 minutes, Maximum 7 minutes (including credits).
- Format: MP4 file, resolution 1080p (Full HD) preferred.
- Content: Films can be documentary, fictional. Original content is highly encouraged. If using copyrighted material (music, images, video clips), proper permission or royalty-free alternatives must be used and cited. AI generated contents and videos will be disqualified.
- Language: English or Tamil (with English subtitles).

Last date of submission: 14.08.2026

Evaluation Criteria:

- Creativity, originality, and artistic merit
- Relevance to sub-theme and scientific accuracy
- Storytelling, narrative coherence, and emotional impact
- Production quality (videography, editing, audio, visual effects)
- Ability to answer questions

Specific Guidelines - 3

Astro Photography

Astro Photography

Objective: To showcase the beauty and wonder of the cosmos through photographic artistry and technical skill.

Eligibility: Open to all registered participants.

Members: Individual or a group of two persons.

Submission Guidelines:

Categories (Participants may submit up to 2 entries as per following category):

- Deep Sky: Galaxies, nebulae, star clusters.
- Planetary/Lunar: Planets, the Moon (detailed surface shots).
- Solar: The Sun (must be safely captured with proper filters).
- Landscape Astrophotography: Night sky elements (Milky Way, constellations) integrated with terrestrial landscapes.

Format: High-resolution JPEG or TIFF files. Minimum resolution 2000 pixels on the longest side.

EXIF Data: Original EXIF data (meta data) must be intact (if possible) for verification of capture details.

Processing: Basic image processing (stacking, stretching, noise reduction, color balance) is allowed. Extensive manipulation that fundamentally alters the original astronomical object will be evaluated accordingly. No composite images (combining separate astronomical objects from different captures) unless stated as a separate category.

Originality: Must be captured and processed by the participant(s). Usage of SEESTAR, MiniDwarf telescopes must be avoided.

Last Date for Submission: 14.08.2026.

Evaluation Criteria:

- Originality and difficulty of capture
- Scientific interest & uniqueness of the captured object
- Technical quality (focus, exposure, noise, clarity)
- Aesthetic appeal and artistic composition
- Ability to answer questions

Specific Guidelines - 4

Development of Innovative Space Related Games

Development of Innovative Space Related Games

Objective: To inspire creativity, coding skills, and scientific understanding through the design and development of engaging digital or board games with a astronomy related contents.

Eligibility: Open to all registered participants.

Members: Individual or a group of two persons.

Submission Guidelines:

- Game Type: Can be a digital game (web-based, desktop executable, mobile app prototype) or a detailed concept for a board game/card game.
- Content: The game must incorporate elements of astronomy, astrophysics, cosmology, or space technology in its core mechanics, objectives, or narrative. Educational value is key.
- Digital Game Submission: Provide a playable prototype (e.g., functional web link, executable file for common OS, or a video demonstration if too complex for direct submission).
- Board Game Concept Submission: Submit a detailed rulebook (PDF), design document with game mechanics, and images of prototype components (e.g., game board, cards, pieces).
- Concept Document: A concise document (max 500 words) outlining the game's objective, target audience, core mechanics, educational relevance, and technological stack/materials used.

Last Date for Submission: 14.08.2026.

Evaluation Criteria:

- Innovativeness and originality of the game concept
- Educational value and scientific accuracy
- Gameplay mechanics, fun factor, and user experience
- Technical execution and functionality (for digital games) / Clarity of design and rulebook (for board games)
- Relevance to the theme and overall presentation

Appendix 1

Model Paper Presentations

These model papers are provided solely for reference purposes. They serve to enhance understanding of research methodology and to illustrate effective paper presentation techniques.

1

Mathematics in Astronomy

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Abstract:

In science education, teaching mathematics is considered as challenging one and often students wondered the real world application of formula that they learn in the class. Mathematics is basically an art of abstraction. But the ability understanding the abstraction strongly depends on the age factor of the student. An undergraduate student understands the theorem in mathematics better than school going student. If a teacher does not take into account this fact, will miserable fail in the classroom. Therefore, the better way to teach math to school going children is to always introduce the math with real world application, so that student will easily grasp the idea of abstraction. Astronomy has lot of scope for teach mathematics in effective way. In this short paper, we discuss how arc-angle formula leads to measuring radius and circumference of earth.

1. Introduction:

Astronomy, the study of celestial objects and phenomena, has been deeply intertwined with mathematics since ancient times. From predicting planetary motions to understanding the structure of the universe, mathematics provides the tools necessary to model, analyse, and interpret astronomical observations. This paper explores the fundamental role of mathematics in astronomy, focusing on its applications in celestial mechanics, astrophysics, and cosmology. In this short paper, we will demonstrate how a simple formula from geometry and trigonometry leads to profound measurement.

2. Arc-angle Formula and radius of the earth:

Circle subtends an angle 2π with respect to point at centre. Part of circle called "arc" of length S subtends an angle $\theta = \frac{S}{R}$. Here R is radius of the circle. It is shown in Figure 1.

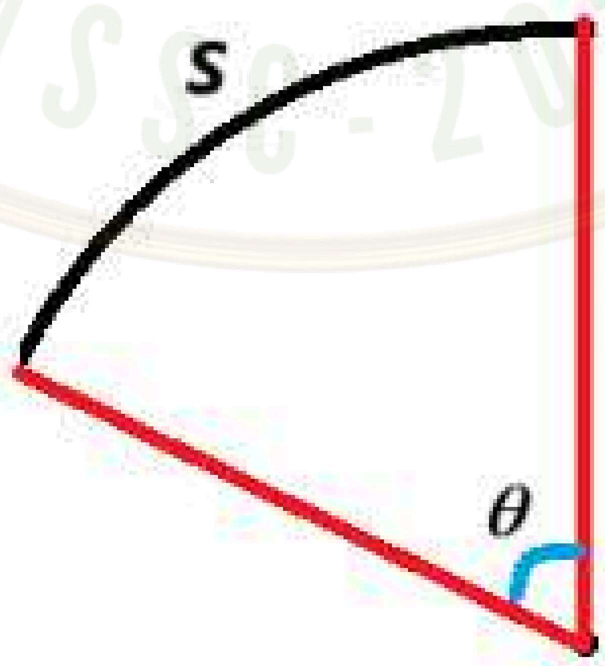

Figure 1 – Arc-angle formula

This formula is taught at the 6th standard level and most of the time, student never appreciate the beauty of this equation. Or it is never being taught to the students in such a way that they are not able to appreciate it. The problem lies either in the teaching methodology or student's disinterest in learning math. To overcome this learning difficulty, teachers must bring lot of interesting natural world applications of mathematics so that student feel that mathematics is a language of nature.

2.1 Eratosthenes enters and assault on Flat earth idea

2200 years ago, a famous Greek astronomer called "Eratosthenes" measured the radius of the earth using this simple formula. He was a chief librarian and geometer in the city of Alexandria. One day, when he was reading a book, he noticed that during noon of summer solstice sun rays strikes the bottom of the well in the nearby city called "Syne". It was surprise to him because sun rays always hit the circumferential area of well and he wondered how it hit the bottom of the well. He also found out that the same solstice day, sun rays hit the circumferential area of the well in the city Alexandria as shown in Figure 2.

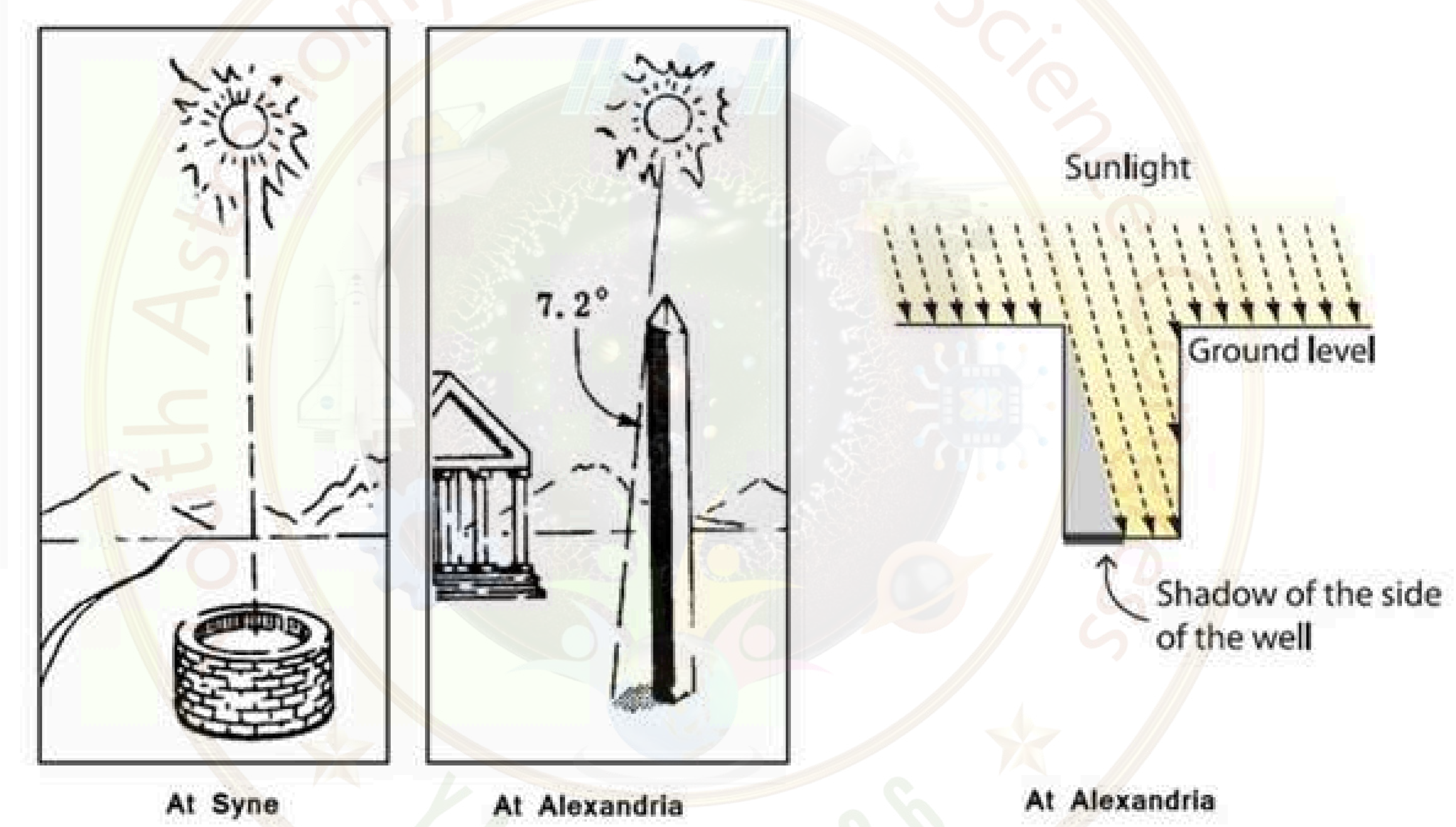

Figure 2 – Sun rays on Summer solstice day in Syne and Alexandria

It was complete surprise to him that on the same day how can in one place sunrays hit the bottom and another place it hits the circumferential area. He argued that if earth were flat, it would not have happened and this could have been possible only if earth is curved. This is first simple proof that earth surface is curved. It is shown in Figure 3.

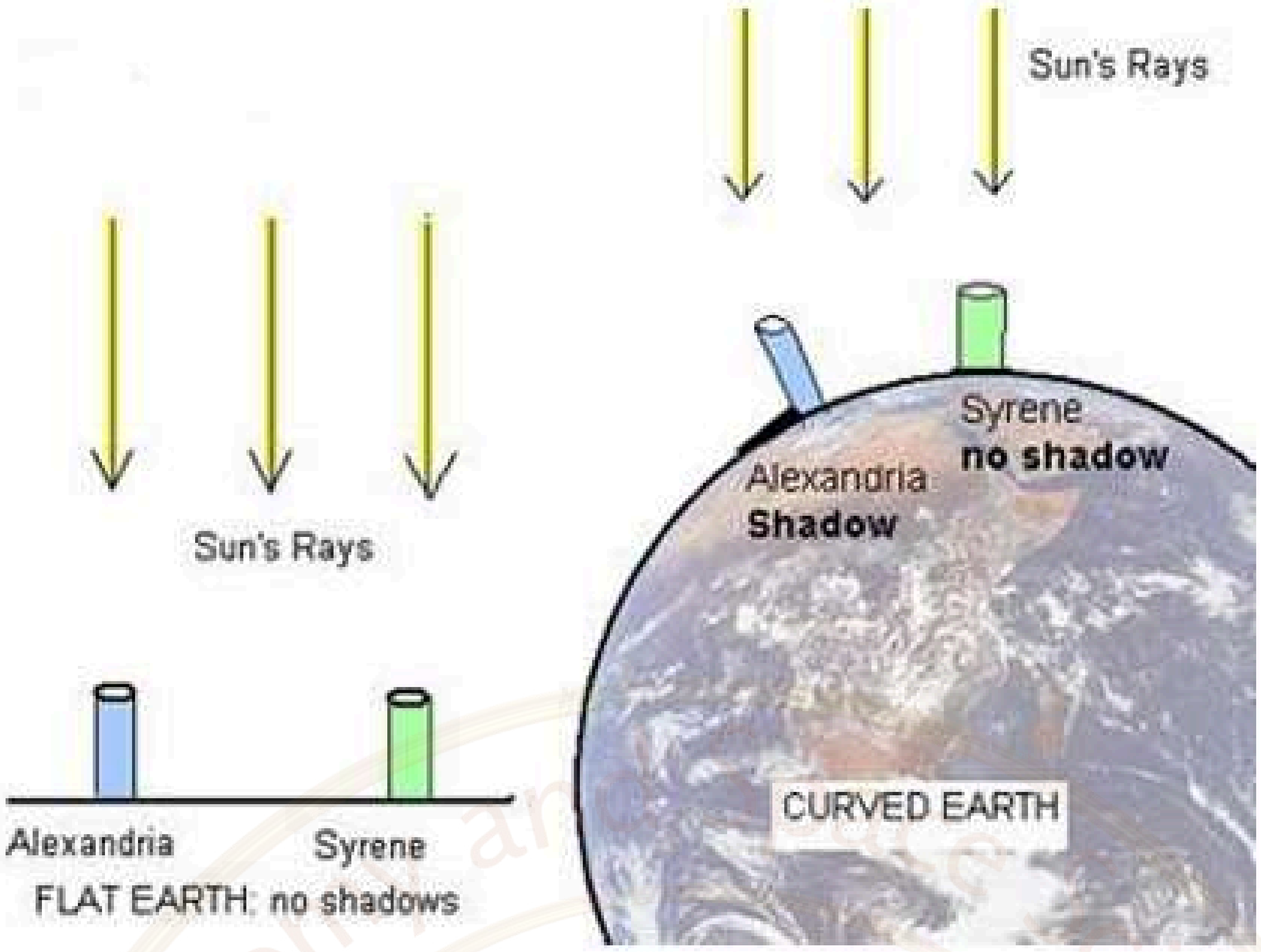

Figure 3 – Flat Earth Vs Round Earth

Since Eratosthenes inferred that earth must be curved and he further guessed that earth must be a smooth sphere. Curved surface does not guarantee that sphere. How Eratosthenes jumped to conclusion that earth must be sphere? He correctly borrowed this idea from Aristotle and his predecessors. Aristotle already observed that the shadow of earth during lunar eclipse was always circle or part of circle. If earth were flat, then the shadow should have been elliptical arc and if earth is some other irregular shape, then we would never observe the circular arc shape shadow on the moon. It is shown in Figure 4.

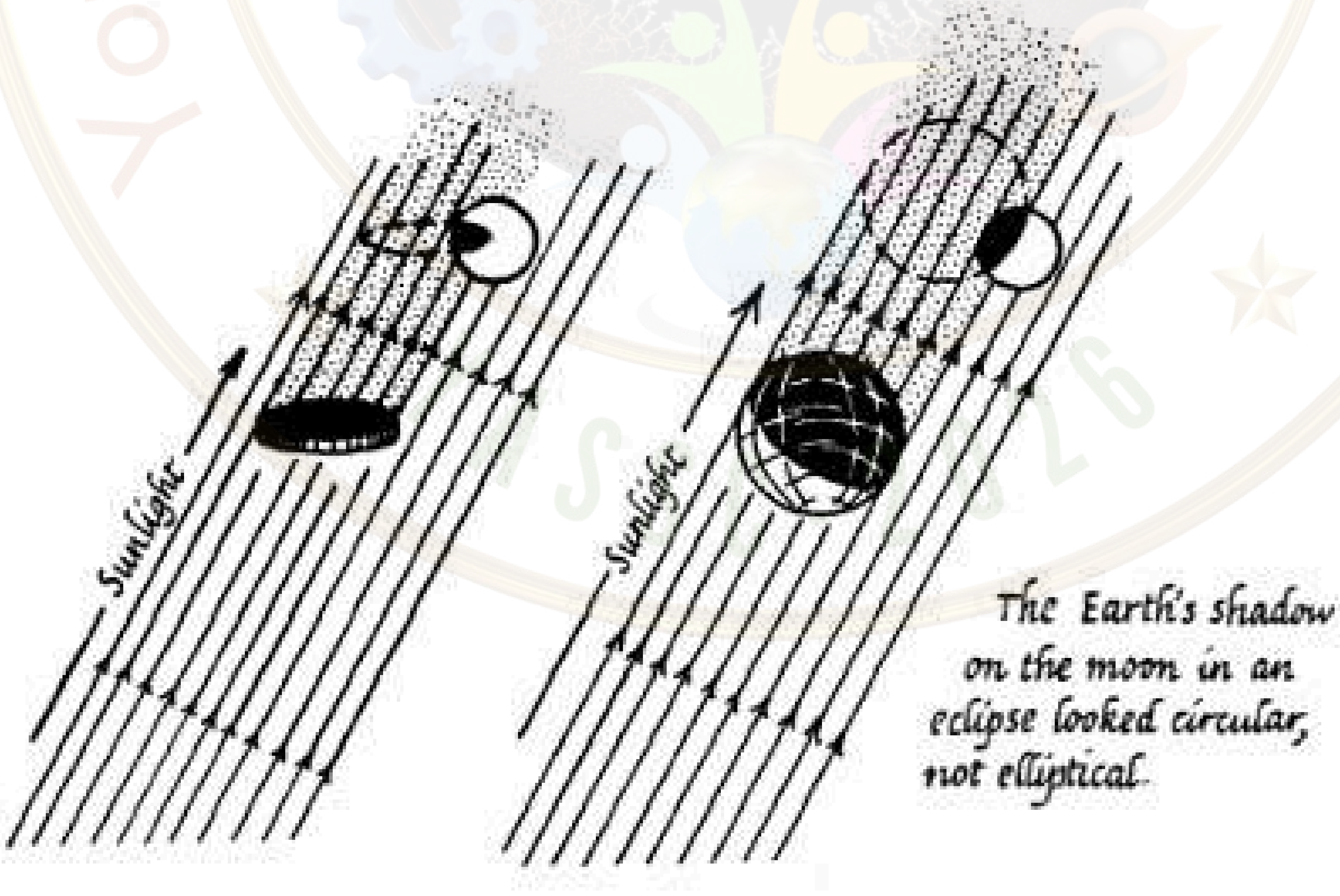

Figure 4 – Aristotle proof that earth must be a sphere not flat

There were some other observations which also lead Eratosthenes to conclude that earth must be smooth sphere. Now he decided to calculate the circumference of the earth and radius of the earth.

2.2 Eratosthenes into action

Eratosthenes brilliantly used the observations at Syne and Alexandria during noon of Summer Solstice. He measured the angle made by sun rays for the vertical pole that was kept Alexandria and found to be 1/50 of the circle (7.2°) and at the same time sun rays makes zero angle in Syne. It is shown in Figure 2. He argued further that if the two lines drawn from the centre of earth to Syne and Alexandria then those two lines also subtends the same angle 1/50th circle (7.2°) as shown in Figure 5. **This is the most extraordinary thought in those time and he correctly connects the geometry with observation.**

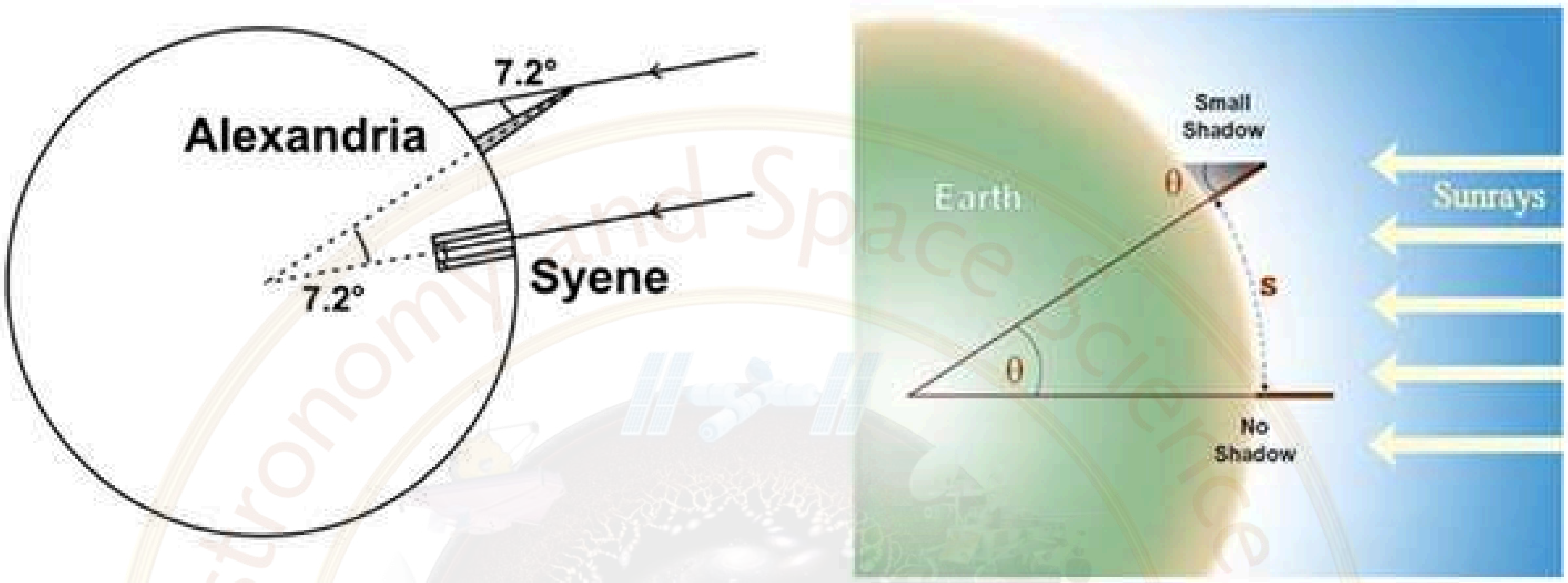

Figure 5 – Connecting the observation with Geometry

He further inferred that since angle between Syne and Alexandria was 1/50th of circle, then the distance between them also 1/50th of the circumference of earth. By knowing the distance between Syne and Alexandria and multiplying it by 50 will give the circumference of earth. **This considered as first astonishing idea in the history of physics.** Using his soldiers, he measured that distance between Syne and Alexandria was 800 km and multiplying by 50, the circumference of earth shown to be 40,000km. This is very close to modern value 40,075km. The error was only 75 km or 0.1%.

To find the radius of the earth, either circumference can be divided by 2π or the arc-angle formula can be directly used without need of circumference value.

$$\textbf{Radius of earth } R = \frac{s}{\theta}$$

Here θ is radian, to use in degree measure, the formula can be re-casted as

$$R = \frac{s}{\theta} \times \frac{180}{\pi}$$

$$R = \frac{800}{7.2} \times \frac{180}{\pi} = 6366\ km$$

The modern value is 6378 km. The error is just 12 km or 0.1%.

How simple arc – angle formula leads to profound measurement. In fact, recently world physics community selected 10 most beautiful experiments in Physics. The Eratosthenes experiment is one among them.

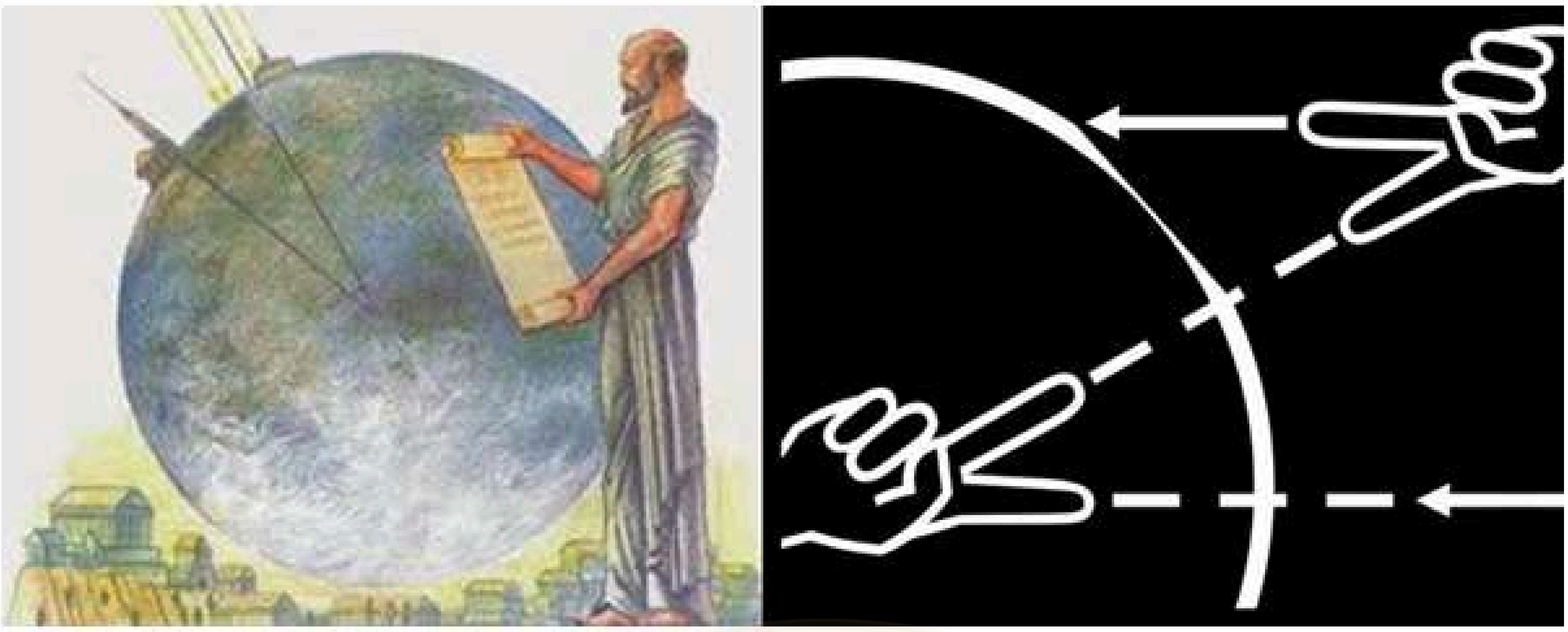

Figure 6 – Eratosthenes experiment – One among the 10 most beautiful experiments in physics

3. Eratosthenes experiment as school project:

Eratosthenes experiment can be given as school project and students can do this experiment on Zero shadow day. On behalf of TASS, we have done this measurement several times in Tamilnadu and various district Astro club members also carried out this experiment. One such measurement is presented here.

MEASURING RADIUS OF EARTH

WORKSHEET

(Eratosthenes method)

Description:

Step 1: keep a straight stick or pole vertically on flat surface and measure the length of shadow between 11.55 am to 12.30 noon

Step 2: Take the shortest length of the shadow and measure the length of the stick

Step 3: Divide the shortest shadow length by pole length and this is the angle θ . Note this is in radian

Step 4: Find the distance (in km) between your place to earth equator. Link is given below. Denote this distance as "S"

Step 5: Earth radius $R = \frac{S}{\theta}$

Date	21-03-2024
Name of your school/college	NMA Gov. HR. SEC. SCHOOL
Address of your place and state and district	PALLAVARAM TAMIL NADU
Latitude and longitude of the place where the experiment is done (To get the latitude and longitude of your place, use google map)	13.0827
Vertical Pole length (in cm)	96

MEASUREMENT

S.No	Time	Shadow length (in cm)
1	11.55 am	28
2	12.00 noon	
3	12.05 noon	25
4	12.07 noon	23
5	12.10 noon	23
6	12.12 noon	22
7	12.14 noon	22
8	12.16 noon	22
9	12.18 noon	22
10	12.20 noon	23.4
11	12.22 noon	23.6
12	12.24 noon	23.8
13	12.26 noon	24
14	12.28 noon	24
14	12.30 noon	24.2
15	12.35 noon	25

1. Finding the angle θ:

- Shortest shadow length (in cm): 22 cm
- The angle that sun rays make with vertical pole

$$\theta = \frac{shortest\ shadow\ length}{pole\ length} = \frac{22}{96} = 0 \cdot 22916 \text{ radian}$$

(Don't round off the value and at least give it in three decimal place)

2. Distance between equator to your place(S):

- Use the following website to get distance from equator to your place
- This distance is called "S" = 1452 km

The radius of the earth $R = \frac{S}{\theta} =$ $1452 / 0.22916 = 6336$ km

The circumference of the earth:

$$C = 2\pi R = 6.28 \times R = 39790.08 \text{ km}$$

3. Error Calculation:

The error in the radius of the earth $\Delta R = R - 6378 =$ 42 km

(The actual value of radius of the earth is 6378 km)

The percentage of error = $\frac{\Delta R}{6378} \times 100$ = 0·658 %

(Why this error occurs? Think of it!!!!!!

4. **Determination of latitude of your place:**

Latitude = $\frac{\theta \times 180}{3.14}$ = 13·136 degrees $\frac{0{\cdot}22916 \times 180}{3{\cdot}14}$

S.No	Student name	Standard
1.	Balakumanan · V	XII
2.	Saranya · S	XII
3.	SiyamalaGowri · V	XII
4.	Adlin bency · S	XII

S.No	Teacher name
1.	Mrs KOUSALYA · S
2.	Mrs · Maithili · P

Conclusion:

In conclusion, the Eratosthenes experiment stands as a testament to the profound interplay between mathematics and astronomy, demonstrating how simple geometric principles can unlock profound insights about our universe. By applying the arc angle formula to the shadows cast during the summer solstice, Eratosthenes not only calculated the Earth's circumference with remarkable accuracy but also laid the groundwork for future explorations in both fields. This elegant fusion of observation and mathematical reasoning highlights the timeless power of mathematics as a tool for understanding the cosmos, reminding us that even the most complex celestial phenomena can often be unravelled through the lens of fundamental mathematical concepts.

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1. Astronomy: A Physical Perspective by Marc L. Kutner
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3. Mathematics for Physicists and Engineers" by Klaus Weltner et al.
4. Cosmos" by Carl Sagan

2

தமிழ் இலக்கியத்தில் வானியல்

கு இரவிக்குமார் , அச்சு தொழில்நுட்ப பயிலகம் சென்னை.

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Abstract (ஆய்வு சுருக்கம்)

தமில் இலக்கியங்களில் பழமையான ஒன்றான நெடுநல்வாடையில் காணப்படும் வானியல் கருத்துக்களை ஆய்வு செய்கிறது இக்கட்டுரை, தலைவனை பிரிந்து வாடும் ஒரு தலைவியின் உணர்வுகளை விவரிக்கும் இந்த பாடல்களில் . வாடைக்காலத்தின் இயற்கை சூழலையும் , பருவ மாற்றங்களையும் பதிவு செய்கிறார் இந்நூலாசிரியர் நக்கீரன் அவர்கள். உச்சி பொழுதை சரியாக கணிப்பதற்கு பயன்படுத்திய ஒரு முறையை , அதாவது இரு கோல் கொண்டு கண்டறியும் ஒரு முறையை ஆசிரியர் இங்கு விரிவாக விளக்குகிறார். இதன் மூலம் சங்ககாலத்தில் வான மக்களின் வானியல் அறிவும் அதன் நடை முறை பயனும் நன்கு புலப்படுகிறது.

key words (முக்கிய கலை சொற்கள்): வானியல், தமிழ் இலக்கியம், நெடுநல்வாடை.

தமிழ் இலக்கியத்தில் வானியல்

கு இரவிக்குமார் , அச்சு தொழில்நுட்ப பயிலகம் சென்னை.

Email id:ravikumark.phy@gmail.com

1. Introduction (அறிமுகம்)

வானியல் என்பது வரலாற்றில் மிகவும் பழமையான அறிவியல் துறைகளில் ஒன்றாகும். வரலாற்றுக்கு முந்தைய நாகரிகங்களில், எடுத்துக்காட்டாக எகிப்து நினைவுச் சின்னங்கள் அவர்களின் வானியல் அறிவைப் பறைசாற்றுகின்றன. மேலும், ஆரம்பகால நாகரிகங்களான பபிலோன், கிரேக்க, இந்திய, ஈரானிய, சீன மற்றும் மாயன் நாகரிகங்களில் குறிப்பிட்ட கால இடைவேளைகளில் விண்வெளியை நோக்காய்வு செய்துள்ளனர்.

இந்த ஆய்வு கட்டுரையில் தமிழின் மிகவும் பழமையான இலக்கியங்களில் காணப்படும் வானியல் சார்ந்த அறிவியல் கருத்துக்களை கண்டு பிடித்து அவற்றின் இன்றய மதிப்பீட்டை பரிசீலனை செய்கிறது

2. Literature review (இலக்கிய ஆய்வு)

நெடுநல்வாடை என்பது, சங்கத் தமிழ் இலக்கிய நூலான பத்துப்பாட்டு நூல்களுள் ஒன்றாகும். பாண்டியன் நெடுஞ்செழியனை பாட்டுடைத் தலைவனாகக் கொண்டு நக்கீரர் எழுதிய நூல். இது பிரிவால் வாடும்

தலைவியின் உணர்வுகளை விவரிக்கிறது . மேலும் வாடைக்காலத்தின் இயற்கை சூழலை, பருவ மாற்றங்களையும், மக்கள் பிரிவுகளையும் காட்சிப்படுத்துகிறது.

3. Objectives (குறிக்கோள்கள்)

- தமிழர்களின் வானியல் அவதானிப்புக்களை அவர்களின் இலக்கிய படைப்புகள் மூலமாக அடையாளப்படுத்துதல் .
- வின்பொருட்கள் (அதாவது இயற்கைத் துணைக்கோள்கள், கோள்கள், விண்மீன்கள், விண்முகில்கள் மற்றும் விண்மீன் பேரடைகள்) பற்றியும், அவற்றின் பற்றிய அவர்களின் பார்வையும் ஆய்வுசெய்தல்.

4. Methods (ஆய்வு முறைகள்)

இந்த ஆய்வு கட்டுரையில் சங்கத் இலக்கியத்தில் பத்துப்பாட்டு நூல்களின் ஒன்றான நக்கீரர் எழுதிய நெடுநல்வாடையில் உள்ள வானியல் விவரங்களை ஆய்வுசெய்கிறோம்.

தமிழ் இலக்கியங்களில் வானியலை நன்கறித்தவர்களை ‘கணியர்’ என குறிப்பிட்டிருக்கின்றன . வான் பொருட்களின் இயக்கத்தை காலத்தை கணித்து கூறுபைராகக் கணியர் திகழ்ந்துள்ளனர் என்பவதயும் இலக்கியச் சான்றுகள் எடுத்துரைக்கின்றன.

……………………………மாதிரம்

விரிகதிர் பரப்பிய வியல்வாய் மண்டிலம்

இரு கோல் குறி நிலை விழுக்காது குடக்கோ்பு

ஒருதிறம் சாரா அனைநாள் அமையத்து

நூலறி புலவா் நுண்ணிதின் கயிறிட்டு

தேஎங் கொண்டு தெய்வ நோக்கிப்

பெரும்பெயா் மன்னா்க் கொப்ப மனை வகுத்து

ஒருங்குடன் வளைஇ ஓங்கு நிலை வரைப்பு

(72–79 நெடுநல்வாடை)

4, Results and discussion (ஆய்வு முடிவுகள்)

பாண்டிய மன்னனுக்கு அரண்மனை கட்டவேண்டி , உச்சி பொழுதை சரியாக கணிப்பதற்கு பயன்படுத்திய முறை இங்கு கூறப்பட்டுள்ளது.

பூமியில் நட்டுவைக்கப்பட்டுள்ள இரண்டு கோல்களை கொண்டு எப்படி அதன் நிழல்களால் மூலம் கண்டுபிடித்தனா் என்பது இங்கு விளக்கப்பட்டுள்ளது.

இந்த ஆய்வு முடிவுகள், பல்வேறு வகையான மக்கள் வான் பொருட்களை அவா்களின் அன்றாட வாழ்க்கைக்கு எப்படி பயன்படுத்திக்கொண்டனா் என்பதையும் இதன் மூலம் நாம் புரிந்துகொள்ள முடியும்

5, References (ஆதார குறிப்புகள்)

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Analysing Satellite Imagery to Study Earth's Atmospheric Changes

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3

1. Introduction

Space technology provides us with a unique view of Earth's atmosphere and environment. Using freely available satellite imagery, students can study major environmental changes such as air pollution, forest loss, or heat islands. This project combines elements of space science and Earth science, helping students understand how human activities influence the planet and how satellites help monitor those changes.

2. Objectives

The primary aim is to introduce students to real satellite data and how it can be used to observe environmental changes. Students will identify trends in atmospheric conditions, track pollution, or monitor vegetation over time. The project also aims to build familiarity with remote sensing technologies and to highlight the connection between human activity and observable changes from space.

3. Materials Needed

Students will need a computer with internet access and access to platforms like NASA Worldview and Sentinel Hub Playground. These tools allow users to view satellite imagery over specific time periods. Students will also use spreadsheet software to record and analyse data. More advanced participants can explore Google Earth Engine for deeper analysis.

4. Methodology

First, students choose a geographic area of interest—such as a city, forest, or coastline—and a specific environmental theme, like deforestation, smog, or urban expansion. They will then gather satellite images from different dates (e.g., pre- and post-event) and analyse visible changes using indices like NDVI for vegetation or aerosol density for air quality. These findings are recorded in spreadsheets for comparison.

5. Data Analysis

Using the collected images and data, students highlight and annotate changes in land use, pollution, or vegetation. They can graph trends over time, identify seasonal variations, or correlate observed changes with real-world events such as wildfires, floods, or festivals. This allows them to draw meaningful conclusions about environmental dynamics.

6. Follow-Up Activities

Students are encouraged to share their findings through posters, blogs, or short videos. They might present their work to environmental clubs or local government bodies, advocating for awareness or policy changes. These outreach activities help students learn to communicate scientific ideas effectively.

7. Expected Learning Outcomes

By completing this project, students will learn how to interpret satellite imagery and extract meaningful information about Earth's atmosphere. They will become familiar with real scientific tools used by researchers and develop data literacy and communication skills. Importantly, they will understand how space-based observation supports solutions to environmental issues on Earth.

Tracking and Modelling the Motion of Planets Using Open-Source Data

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4

1. Introduction

Planetary motion has long intrigued observers of the night sky. Today, thanks to open-source planetarium tools and NASA databases, students can track the actual paths of planets and understand celestial mechanics. This project allows them to observe, record, and model the movement of planets, gaining insight into how early astronomers discovered the laws that govern the solar system.

2. Objectives

The goals of this project are to help students track a planet's position over time, understand phenomena like retrograde motion, and simulate planetary orbits. Students will also explore foundational concepts in astronomy such as Kepler's Laws and Newton's laws of motion, gaining a deeper appreciation for how planetary motion is governed by physics.

3. Materials Needed

Key tools include planetarium software such as Stellarium for daily tracking, and online databases like NASA's JPL HORIZONS. Students will also use spreadsheets for plotting and, optionally, Python with AstroPy and Matplotlib to simulate orbits. A notebook is recommended for maintaining observation logs.

4. Methodology

Students begin by selecting a visible planet—Mars, Venus, or Jupiter. Using Stellarium or similar tools, they will record the planet's position (RA/Dec or Alt-Az) over 30 to 60 days. These data points are logged daily or weekly and entered into spreadsheets. Once collected, the data is used to plot the planet's apparent motion across the sky.

5. Data Analysis

The recorded planetary positions are analysed to identify interesting patterns such as retrograde motion or varying orbital speeds. Students will simulate orbits using software or calculations and compare their findings to predictions from Kepler's Laws, such as the elliptical nature of orbits and the relationship between orbit size and period.

6. Follow-Up Activities

As an extension, students can compare modern planetary motion with historical models like those of Ptolemy and Copernicus. They may also prepare presentations or short videos explaining their findings or attempt basic coding simulations of planetary orbits, such as 2-body problems in Python.

7. Expected Learning Outcomes

This project helps students grasp how astronomers' study planetary motion and builds their skills in observation, data plotting, and simulation. It introduces them to celestial mechanics and fosters an appreciation for how modern astronomy builds upon centuries of observations and theory.

Mapping Light Pollution in Your City Using Citizen Science Tools

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1. Introduction

Light pollution is the result of excessive or poorly directed artificial lighting that brightens the night sky and obstructs the visibility of stars and celestial bodies. This phenomenon not only diminishes our ability to observe the universe but also disturbs wildlife, disrupts natural circadian rhythms, and wastes energy. In this project, students will explore how light pollution varies across different areas and contributes meaningful data to global citizen science initiatives.

2. Objectives

The project aims to help students measure and analyse light pollution in various locations. By comparing different areas like cities and rural towns, students will understand how urbanization affects night sky visibility. The project also seeks to raise awareness about the ecological and astronomical impacts of light pollution and encourages participation in global campaigns using tools like Globe at Night.

3. Materials Needed

Students will need a smartphone or tablet equipped with internet access and apps such as Stellarium or SkySafari for identifying constellations. They will use the Globe at Night website to report their findings. Optional tools include a Sky Quality Meter (SQM) for more precise readings. Data can be recorded manually in notebooks or digitally using spreadsheets.

4. Methodology

Students will first identify several observation points with different population densities—such as urban centres, suburban areas, and rural locations. Observations should take place after 8 PM on clear nights and ideally during a new moon phase. At each site, students will locate a constellation (e.g., Orion) using a star map app, then count the visible stars and compare their visibility to Globe at Night's charts. Data is either submitted online or logged for later use.

5. Data Analysis

Once data is collected from multiple sites and dates, students will analyse differences in star visibility and light pollution levels. They can create graphs showing patterns in sky brightness and link these patterns to surrounding land use. Over time, students can explore trends or changes during specific events like Earth Hour.

6. Follow-Up Activities

To spread awareness, students can design posters, host presentations, or write articles about their findings. They may also participate in global light pollution awareness campaigns. These activities encourage them to share their knowledge with the public and inspire actions to reduce unnecessary lighting.

7. Expected Learning Outcomes

Through this project, students will learn how to carry out scientific observations, manage and interpret data, and use digital tools for analysis. They will gain an understanding of the environmental effects of artificial lighting and how citizen science can contribute to solving global problems.

Building a Simple Radio Telescope to Detect Solar Activity

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1. Introduction

Radio astronomy allows us to observe celestial objects by detecting radio waves rather than visible light. The Sun, in particular, is a strong emitter of radio waves, especially during solar flares and coronal mass ejections. In this project, students will build a simple radio telescope using affordable components like a satellite dish and a software-defined radio (SDR) receiver. The aim is to detect solar radio bursts and understand the dynamic nature of solar activity and its effect on Earth.

2. Objectives

The project introduces students to the basics of radio astronomy and electromagnetic spectrum observation. It aims to make students familiar with solar phenomena such as solar flares and their radio signatures. Through hands-on construction and signal monitoring, students will develop a practical understanding of how solar activity can be detected using radio frequencies.

3. Materials Needed

The setup requires a satellite TV dish, an SDR receiver (such as RTL-SDR), a USB-compatible computer, and free software like SDR# (SDRSharp) or GQRX for signal visualization. Additional items include coaxial cables, a tripod or mounting system, and basic tools. Safety precautions must be taken while installing equipment outdoors.

4. Methodology

Students will assemble the radio telescope by mounting the dish and connecting it to the SDR receiver and software. Once calibrated, the system is aimed at the Sun, and radio signals in specific bands (typically around 20 MHz–30 MHz) are monitored. Observations should be recorded at regular intervals, and any spikes in signal intensity may indicate solar events.

5. Data Analysis

Data is visualized using software to detect unusual patterns or bursts. Students can correlate their observations with reports from solar monitoring websites (e.g., NASA, NOAA, or Space Weather Live). They can compare quiet and active solar days, helping them interpret how solar radio emissions fluctuate.

6. Follow-Up Activities

Students can compile their results into a solar activity report and compare it with global datasets. They may also present their design to peer groups or science fairs, explaining how amateur radio astronomy contributes to space weather monitoring.

7. Expected Learning Outcomes

Students will gain hands-on experience in building scientific instruments, working with radio waves, and monitoring solar phenomena. They will understand how solar activity affects Earth and appreciate how radio astronomy complements optical observations in modern astronomy.

Designing a Mars Habitat Prototype Using Space Science Principles

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1. Introduction

With NASA, ESA, and private companies like SpaceX preparing for human missions to Mars, designing sustainable living habitats on Mars is a key scientific and engineering challenge. This project allows students to integrate knowledge from astronomy, space science, environmental science, and engineering to create a prototype design of a habitat suitable for life on Mars.

2. Objectives

Students will explore the Martian environment—including gravity, temperature, radiation, atmosphere, and terrain—and design a model habitat that addresses human needs. The project encourages interdisciplinary thinking and problem-solving, blending theoretical research with practical creativity.

3. Materials Needed

This is primarily a design project, so students will use paper, cardboard, 3D models (optional), and software tools like Tinkercad or SketchUp. Access to NASA Mars mission data and Martian environmental facts will support the research. Presentation tools like posters or slides can be used to share their design.

4. Methodology

Students will begin by researching conditions on Mars, including daily temperatures, dust storms, thin CO_2-rich atmosphere, and lack of liquid water. Then they will brainstorm ways to meet basic needs such as oxygen production, waste recycling, food growing, radiation shielding, and energy supply. The habitat design can be drawn, modelled physically, or created digitally.

5. Data Analysis

Students will explain how each feature of their habitat addresses a specific Martian challenge. For example, they might propose growing food in hydroponic units powered by solar panels or using Martian regolith for building insulation. The design should include a layout of rooms and systems (life support, energy, recycling).

6. Follow-Up Activities

Students can present their design in a model exhibition or competition, or write a proposal as if submitting it to a space agency. They can also compare their design with actual Mars habitat concepts by NASA or other institutions.

7. Expected Learning Outcomes

This project cultivates creativity, critical thinking, and collaboration. Students will learn how environmental factors shape engineering design and appreciate the complex planning needed for human survival in space. It introduces space architecture, sustainability, and real-world science fiction turning into science fact.

Asteroid Mining: A Survey of Advancements in Extraterrestrial Resource Utilization

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Abstract: Asteroid mining, once a staple of science fiction, is rapidly progressing towards becoming a tangible reality, driven by the potential for abundant space resources critical for deep-space exploration and terrestrial applications. This survey paper synthesizes recent advancements across various facets of asteroid mining, drawing insights from ten contemporary research articles published between 2020 and 2025. It examines key developments in resource extraction methodologies, strategic mission planning, the economic viability and associated cost models, and the evolving landscape of governance, policy, and international cooperation. The reviewed literature highlights the multidisciplinary nature of this emerging field, underscoring the interconnected challenges and opportunities in engineering, economics, and international law. While significant technological and financial hurdles remain, the collective research indicates a growing scientific consensus on the feasibility and strategic importance of asteroid resource utilization, paving the way for sustainable human expansion into the solar system.

Keywords: Asteroid Mining, Space Resources, In-Situ Resource Utilization (ISRU), Space Policy, Space Economy, Mission Design, Optical Mining.

Introduction

The vast expanse of our solar system contains a wealth of untapped resources, with asteroids emerging as prime candidates for extraterrestrial resource utilization (ESRU). These celestial bodies, remnants from the early solar system, are believed to harbor significant quantities of water ice, precious metals, and other valuable minerals that could revolutionize space exploration by enabling in-situ propellant production, constructing space infrastructure, and potentially augmenting terrestrial resource supplies. Beyond the economic incentives, asteroid mining presents a strategic imperative for long-duration human missions, offering a pathway to self-sufficiency and reduced reliance on Earth-launched materials.

However, the realization of asteroid mining presents formidable scientific, technological, economic, and geopolitical challenges. This survey aims to consolidate and critically review recent advancements in this multidisciplinary field, drawing insights from ten selected research papers published between 2020 and 2025. By synthesizing findings across various domains—from innovative mining techniques and strategic mission design to economic models and legal frameworks—this paper provides a snapshot of the current state of asteroid mining research. It seeks to identify key trends, highlight interdependencies between different research areas, and underscore the complex considerations necessary for the successful and sustainable exploitation of extraterrestrial resources.

Technological Advancements in Asteroid Resource Extraction and Processing

The effective extraction and processing of resources in the microgravity environment of asteroids pose significant engineering challenges. Researchers are actively exploring novel methods to overcome these hurdles, moving beyond traditional terrestrial mining paradigms. One such innovative approach is optical mining, which is explored by Darling et al. (Broslav,

T. et al., 2025). Their work on optical mining of carbonaceous chondrite simulants provides crucial empirical data and lessons learned. This method, leveraging concentrated solar energy to sublimate volatiles or fracture material, offers a promising non-contact approach suitable for the vacuum and low-gravity conditions of asteroids, potentially reducing the need for heavy, complex mechanical tools. The testing and lessons learned from their research are vital for validating theoretical models and guiding future hardware development for efficient resource recovery from various asteroid types.

Another critical technological challenge lies in managing the rotational dynamics of asteroids. Many asteroids are rotating, and uncontrolled rotation (detumbling) can complicate rendezvous, docking, and mining operations. Nadoushan, Ghobadi, and Shafaee (Nadoushan, M. J. et al., 2020) address this by focusing on designing reliable detumbling missions for asteroid mining. Their research into mission design for active detumbling is fundamental, as a stable platform is prerequisite for precision mining. The ability to effectively control an asteroid's spin is essential for deploying mining equipment, processing resources, and ensuring the safety and stability of the entire operation, highlighting a key area where advanced robotics and control systems are indispensable.

Furthermore, Dong, Sun, and Li (Dong, L. et al., 2020) advocate for safe and clean mining practices, extending principles from Earth-bound operations to asteroids. While their paper broadly discusses clean mining on Earth and asteroids, it implicitly touches upon the technological considerations for minimizing environmental impact in space. This suggests that future technological advancements will not only focus on efficiency but also on sustainability, reducing debris and ensuring responsible resource utilization to avoid contaminating the space environment.

Strategic Mission Planning and Logistics

Beyond the immediate mining techniques, the long-term feasibility of asteroid mining hinges on strategic mission planning and logistical optimization. This involves selecting appropriate targets and establishing effective operational bases in space.

Xie, Bennett, and Dempster (Xie, R. et al., 2021) delve into target evaluation for near-Earth asteroid long-term mining missions. Their research identifies key criteria for selecting suitable asteroids, considering not just resource abundance but also orbital mechanics, accessibility, and the energy required for rendezvous and resource return. This involves complex trajectory analysis and risk assessment, ensuring that missions are not only resource-rich but also economically and operationally feasible over extended periods. Their work is crucial for prioritizing targets in the vast population of near-Earth asteroids (NEAs).

Complementing this, Taylor, McDowell, and Elvis (Taylor, A. J. et al., 2022) explore the concept of Phobos and Mars orbit as a potential base for asteroid exploration and mining. Establishing an intermediate staging post, particularly around Mars, could significantly reduce the delta-V requirements for missions to and from the asteroid belt, thereby optimizing fuel consumption and mission duration. Phobos, as a natural satellite of Mars, presents an intriguing possibility for a deep-space resource hub, offering protection, easier access to materials, and potentially enabling in-situ resource utilization for future Mars missions or onward journeys into the main asteroid belt. This strategic thinking moves beyond individual mining operations to consider the broader infrastructure required for a sustained space resource economy.

Economic Viability and Cost Modeling

The commercialization of asteroid mining is fundamentally dependent on its economic viability. Several papers within this collection directly address the financial aspects, including cost assessment and the impact of propulsion technologies.

Hein, Matheson, and Fries (Hein, A. M. et al., 2020) conduct a techno-economic analysis of asteroid mining, providing a comprehensive framework for assessing the financial feasibility of such ventures. Their work likely models the costs associated with mission design, launch, resource extraction, processing, and transportation, juxtaposing these against the potential market value of the extracted materials. Similarly, Probst, Nitzl, and Förstner (Probst, A. et al., 2020) contribute to the financial modeling of asteroid mining by proposing a cost estimation model using Partial Least Squares Structural Equation Modelling (PLS-SEM). This advanced statistical approach helps in understanding the complex interdependencies between various cost drivers and operational factors, offering a more robust and nuanced cost prediction for these highly complex missions.

Vergaaij, McInnes, and Ceriotti (Vergaaij, M. et al., 2021) analyze the economic assessment of high-thrust and solar-sail propulsion for near-Earth asteroid mining. Propulsion is a major cost driver in space missions, and their research compares the economic efficiency of different propulsion systems. Solar sails, for instance, offer a fuel-efficient but potentially slower alternative to traditional chemical or electric propulsion, with significant implications for mission duration and overall return on investment. Their findings are critical for optimizing mission design to minimize operational costs and maximize profitability.

Governance, Policy, and Global Cooperation

The nascent field of asteroid mining also necessitates robust legal and policy frameworks to ensure peaceful and equitable development. Without clear international agreements, the potential for conflict over extraterrestrial resources could escalate.

Semerád (Semerád, P., 2023) proposes an asteroid mining tax as a tool to keep peace in outer space. This radical concept suggests that a globally agreed-upon taxation mechanism for asteroid-derived resources could not only generate revenue for shared space infrastructure or development funds but also act as a disincentive for aggressive unilateral resource claims, thus promoting stability and cooperation. Such a tax could also be leveraged to ensure equitable distribution of benefits and address concerns about resource monopolization.

Fan, Zhang, and Gao (Fan, R. et al., 2023) explore global cooperation in asteroid mining based on AHP, entropy, and TOPSIS. Their application of multi-criteria decision-making methods to analyze cooperation models underscores the complex interplay of economic, technological, and geopolitical factors in fostering international partnerships. This research highlights the necessity of collaborative frameworks to share risks, pool resources, and establish common standards for responsible space resource utilization. The establishment of international norms and mechanisms is crucial to avoid a "Wild West" scenario in space.

Discussions

The surveyed papers collectively illustrate the formidable yet increasingly surmountable challenges inherent in asteroid mining. There is a clear progression from foundational conceptualization to detailed technical and economic modeling. The research highlights a critical interdependency: technological advancements in extraction (Broslav, T. et al., 2025), detumbling (Nadoushan, M. J. et al., 2020), and efficient propulsion (Vergaaij, M. et al., 2021) are prerequisites for achieving economic viability (Hein, A. M. et al., 2020; Probst, A. et al., 2020), which in turn drives strategic mission planning (Taylor, A. J. et al., 2022; Xie, R. et al., 2021). Furthermore, the need for robust governance and international cooperation (Semerád, P., 2023; Fan, R. et al., 2023) is a consistent theme, as technical feasibility must be matched by a stable legal and political environment to attract necessary investment and ensure long-term sustainability. The emphasis on "clean mining" (Dong, L. et al., 2020) also indicates a growing awareness of environmental stewardship, suggesting that future space resource development will need to integrate sustainability principles from its inception. These papers collectively demonstrate that asteroid mining is no longer a purely theoretical exercise but a multidisciplinary endeavor requiring integrated solutions across science, engineering, economics, and law.

Conclusion

The body of research published between 2020 and 2025 on asteroid mining underscores the field's rapid maturation and its trajectory towards practical implementation. Key areas of advancement include innovative methods for resource extraction like optical mining, refined approaches to mission planning and target selection, sophisticated economic and cost modeling techniques, and a growing emphasis on international cooperation and regulatory frameworks. While significant hurdles persist, particularly concerning the high initial capital investment, the development of robust in-situ resource utilization technologies, and the establishment of comprehensive space governance, the concerted global scientific and engineering efforts signal a strong commitment to overcoming these challenges. The successful realization of asteroid mining holds the potential to profoundly transform humanity's presence in space, offering a sustainable pathway for deep-space exploration and potentially contributing valuable resources to Earth. Continued research, international collaboration, and the progressive development of enabling technologies will be paramount in transforming this vision into a tangible reality.

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A ROADMAP TO THE STAR TRAVEL: ADVANCEMENTS IN INTERSTELLAR PROPULSION

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ABSTRACT: The human quest for exploration extends beyond the confines of our solar system, with interstellar travel representing a grand challenge for 21st-century science and engineering. This paper provides a comprehensive review of theoretical and conceptual propulsion technologies aimed at traversing the vast distances between stars. It synthesizes insights from various propulsion concepts, including conventional chemical and nuclear rockets, ion drives, solar sails, and more advanced speculative designs such as fusion, matter-antimatter, and laser-powered nanosails. A particular focus is placed on the Breakthrough Starshot initiative's proposed method for reaching the Alpha Centauri star system. The paper also highlights the multifaceted importance of interstellar endeavors, encompassing scientific discovery, technological innovation, and the long-term future of humanity. While formidable challenges remain, ongoing research suggests that interstellar flight, once a staple of science fiction, is gradually transitioning into the realm of scientific possibility.

Keywords: Interstellar Travel, Space Propulsion, Alpha Centauri, Breakthrough Starshot, Nanosails, Fusion Propulsion, Antimatter Propulsion.

INTRODUCTION

Humanity's innate drive to explore has consistently pushed the boundaries of our known universe, from navigating oceans to venturing into Earth's orbit and exploring the solar system. The next logical, albeit immensely challenging, frontier is interstellar travel – journeys to other stars and their potential planetary systems. The sheer scale of interstellar distances, measured in light-years, presents a formidable hurdle, requiring propulsion technologies far beyond current capabilities. For instance, even the closest star system, Alpha Centauri, is approximately 4.37 light-years away, a journey that would take tens of thousands of years with conventional spacecraft (NASA, 2025).

However, recent advancements in fundamental physics, materials science, and energy generation have ignited renewed optimism regarding the feasibility of interstellar flight within a human generation. This paper aims to provide a structured overview of the current landscape of interstellar propulsion research. It will survey the various conceptual approaches, from incrementally advanced extensions of current technologies to revolutionary speculative designs. A detailed examination of the Breakthrough Starshot initiative, which proposes a novel approach to reach the Alpha Centauri system, will be presented. Finally, the paper will discuss the profound scientific, technological, and existential importance of undertaking such audacious interstellar endeavors.

LITERATURE REVIEW ON VARIOUS CONCEPTS OF TRAVELING TO STARS

The challenge of interstellar travel necessitates propulsion systems capable of achieving a significant fraction of the speed of light (relativistic speeds) to reduce transit times to manageable decades rather than millennia (Long, 2012). Numerous concepts have been proposed, each with distinct advantages, limitations, and technological readiness levels.

Chemical Rockets:

The backbone of contemporary space exploration, chemical rockets operate by expelling hot gases produced from the combustion of propellants. While highly effective for escaping Earth's gravity and maneuvering within the solar system, their energy density is inherently limited. The rocket equation dictates that an enormous amount of propellant is needed to accelerate a small payload, making them impractical for interstellar distances due as they would require a mass ratio of propellant to payload that is astronomically high (NASA, 2025).

Nuclear Propulsion (Fission-based):

Nuclear propulsion leverages the immense energy released from **nuclear fission** (splitting atomic nuclei).

- **Nuclear Thermal Propulsion (NTP):** In NTP, a fission reactor heats a propellant (typically liquid hydrogen) to extreme temperatures. The superheated gas is then expelled through a nozzle, providing significantly higher specific impulse (fuel efficiency) than chemical rockets, allowing for faster transit times within the solar system, particularly for Mars missions (NASA, 2025).
- **Nuclear Electric Propulsion (NEP):** Here, the fission reactor generates electricity, which powers high-efficiency electric thrusters (like ion engines). While offering even higher specific impulse than NTP, their thrust is very low, necessitating prolonged acceleration periods (Long, 2012).
- **Challenges:** Despite offering considerable performance improvements over chemical rockets, fission-based systems face significant challenges related to the handling and storage of radioactive materials, reactor shielding, and political concerns regarding their deployment and safety (The Aerospace Corporation, 2023).

Ion Drives (Electric Propulsion):

Ion drives, a form of electric propulsion, accelerate charged particles (ions) using electric or magnetic fields to generate thrust. They are characterized by extremely high specific impulse, meaning they use very little propellant for extended periods. Missions like NASA's Dawn spacecraft have successfully utilized ion propulsion for efficient, long-duration journeys within the solar system. However, their thrust levels are extremely low, making them unsuitable for rapid acceleration or departure from massive gravity wells, and requiring years to achieve significant velocities for interstellar distances (Goebel & Katz, 2008).

Solar Sails:

Solar sails harness the momentum of photons from the Sun to generate thrust, similar to how a sailboat uses wind. These large, ultra-thin, highly reflective membranes require no propellant, offering a "fuel-less" propulsion method. While demonstrated successfully within the solar system (e.g., JAXA's IKAROS), the inverse-square law dictates that solar radiation pressure diminishes rapidly with distance from the Sun. This makes solar sails highly effective for inner solar system travel but progressively less efficient for reaching interstellar velocities, as the thrust becomes negligible beyond the Sun's strong influence (Maccone, 2009).

Fusion Propulsion:

Fusion propulsion seeks to harness the energy released by **nuclear fusion**, the process that powers stars, by combining light atomic nuclei (e.g., isotopes of hydrogen like deuterium and tritium). This reaction, if controlled, could yield immense energy per unit mass, far exceeding fission. Theoretical designs propose either directly expelling the superheated plasma from a fusion reaction or using its energy to heat a propellant. Fusion-powered rockets theoretically offer unprecedented specific impulse and higher thrust than electric propulsion, potentially enabling much faster transits within the solar system and even to nearby stars within decades (Wetzell, 2008; Krupakar et al., 2016). The main challenge remains achieving and sustaining a controlled, net-energy-producing fusion reaction in a compact, space-worthy reactor, a scientific and engineering grand challenge still being pursued on Earth (FIA, 2025).

Matter-Antimatter Propulsion:

Often considered the ultimate theoretical propulsion system, matter-antimatter propulsion leverages the complete annihilation of matter and antimatter (e.g., protons and antiprotons, electrons and positrons). According to Einstein's famous equation $E=mc^2$, this process converts nearly 100% of the mass into pure energy, producing the highest possible energy density of any known reaction (Morgan, 1982). This could theoretically yield exhaust velocities close to the speed of light, making interstellar travel feasible within a few years or decades (Morgan & Morgan, 2012). However, the practical challenges are monumental: antimatter is incredibly difficult and expensive to produce in significant quantities (currently picograms per year), and storing it without it coming into contact with ordinary matter (which would result in annihilation) for extended periods is an unsolved engineering problem (Jackson & Howe, 2012; Handmer, 2024).

Laser-Powered Nanosails (Breakthrough Starshot):

This concept, championed by the Breakthrough Starshot initiative, offers a radical departure from carrying fuel onboard. Instead, it proposes propelling ultra-lightweight probes (nanosatellites or "StarChips") by shining powerful lasers on their highly reflective lightsails. This method bypasses the limitations of onboard propellant and aims for truly relativistic speeds. The technology is rapidly advancing, with research focusing on highly reflective photonic crystal membranes (Sieben, 2025; Chang et al., 2024). This approach offers a potentially viable path to interstellar travel within a human generation, despite its own engineering and financial challenges.

Other Concepts:

While beyond the immediate scope of current development, other highly speculative concepts include interstellar ramjets (scooping interstellar hydrogen for fusion fuel), warp drives (manipulating spacetime), and wormholes, which remain firmly in the realm of theoretical physics and science fiction (Milligan et al., 2020; Alcubierre, 1994).

TRAVELING TO ALPHA CENTAURI STAR SYSTEM: A STEP-BY-STEP PROCESS

The Breakthrough Starshot initiative, formally announced in 2016, is a proof-of-concept program designed to demonstrate the feasibility of sending ultra-fast, light-driven nanosatellites to the Alpha Centauri star system. This ambitious endeavor outlines a multi-stage process to overcome the immense distances involved (Breakthrough Initiatives, 2025).

The proposed mission profile can be summarized in five key steps:

1. **Micro-Probe Assembly:**

The core of the mission involves developing and mass-producing **gram-scale StarChips** – fully functional, miniaturized spacecraft carrying cameras, navigation systems, and communication equipment. These StarChips would be attached to **ultra-thin lightsails**, potentially several meters in size, engineered from advanced materials like photonic crystal membranes to optimize reflectivity and minimize mass (Sieben, 2025). The intricate design of these membranes, including "holes" or patterns, allows for high broadband reflectivity while keeping the sail lightweight and resilient under intense laser illumination (Chang et al., 2024).

2. **Gigawatt Laser Array:**

A critical component is the construction of a powerful, ground-based, phased-array laser system. This "light beamer" would comprise numerous interconnected lasers, collectively capable of generating up to 100 gigawatts (GW) of continuous power. This immense power is necessary to impart sufficient momentum to the lightweight sails (Breakthrough Initiatives, 2025).

3. **Rapid Relativistic Acceleration:**

A "mothership" would first deploy a fleet of thousands of StarChips into a high-altitude Earth orbit, above the distorting effects of the atmosphere. The ground-based laser array would then individually target and illuminate each lightsail. Over a period of approximately 10 minutes, the intense light pressure would accelerate each StarChip to an astonishing 15% to 20% of the speed of light, reaching truly relativistic velocities (Breakthrough Initiatives, 2025). The short acceleration window necessitates extremely high accelerations, which the miniaturized StarChips are designed to withstand.

4. **Interstellar Cruise:**

Once accelerated, the StarChips would embark on an unpowered, passive cruise phase through interstellar space. At these speeds, the journey to the Alpha Centauri system, located about 4.37 light-years away, would take approximately 20 to 30 years (Breakthrough Initiatives, 2025). During this phase, the probes would need to autonomously navigate and withstand potential impacts from interstellar dust particles.

5. **Data Collection & Transmission:**

Upon nearing the Alpha Centauri system, the StarChips would perform a rapid flyby. From a distance of about one astronomical unit (Earth-Sun distance) from any target exoplanets, their onboard cameras and sensors would collect vital scientific data and potentially capture high-resolution images. This data would then be transmitted back to Earth using a compact onboard laser communication system, with the signals taking approximately 4 years to reach us (Breakthrough Initiatives, 2025).

IMPORTANCE OF GOING TO THE ALPHA CENTAURI STAR SYSTEM

The ambitious goal of sending probes to Alpha Centauri is driven by a confluence of compelling scientific, technological, and existential motivations.

Proximity and Scientific Exploration:

Alpha Centauri is the closest star system to our Sun, making it the most accessible interstellar target. It is a triple-star system consisting of Alpha Centauri A (Sun-like), Alpha Centauri B (slightly smaller), and Proxima Centauri (a red dwarf). The discovery of **Proxima Centauri b** in 2016, an Earth-sized exoplanet orbiting within Proxima Centauri's habitable zone, significantly amplified the scientific interest in the system (Anglada-Escudé et al., 2016). While the habitability of Proxima b is still under intense debate due to its host star's flaring activity, direct observation and data from a flyby probe would provide unprecedented insights into its atmospheric composition, surface conditions, and potential for life (Barnes et al., 2016; Garraffo et al., 2017). Even if Proxima b proves uninhabitable, the system may harbor other undiscovered planets or offer crucial data on planetary formation around different star types.

Technological Innovation and Spin-offs:

The pursuit of interstellar flight necessitates breakthroughs across numerous scientific and engineering disciplines. Developing ultra-lightweight, highly reflective sails, high-power phased-array lasers, miniaturized spacecraft with advanced sensors, robust communication systems across vast distances, and autonomous navigation capabilities would have transformative spin-off applications within our solar system. These advancements could revolutionize interplanetary travel, enable novel Earth observation platforms, enhance deep-space communication, and lead to new materials and energy solutions (Loeb, 2018). The "Starshot" endeavor acts as a powerful catalyst for innovation, pushing the boundaries of what is currently considered possible.

Understanding Planetary Formation and Evolution:

Visiting another star system provides a unique opportunity to test and refine our models of stellar and planetary formation beyond our own solar system. Observations from a close-range probe could provide empirical data on the composition of different exoplanets, the dynamics of multi-star systems, and the conditions for planet formation in environments different from our Sun's (Loeb, 2018). This comparative planetology would deepen our understanding of our own cosmic origins and the prevalence of planetary systems throughout the galaxy.

The Future of Humanity and Exploration:

Interstellar travel represents the ultimate expression of humanity's exploratory spirit. Successfully launching a mission to Alpha Centauri would not only be a monumental scientific achievement but also a profound statement about our species' ingenuity, resilience, and ambition. It would inspire future generations, solidify our role as an interstellar species, and potentially lay the groundwork for long-term expansion into the galaxy, securing humanity's future against potential existential threats on Earth (Lubin, 2016).

CONCLUSION

The dream of interstellar travel, long confined to speculative thought, is experiencing a resurgence fueled by rapid advancements in technology and a re-evaluation of fundamental physics. While conventional propulsion systems are inadequate for traversing light-year distances within practical timescales, visionary concepts like laser-powered nanosails offer a promising pathway. The Breakthrough Starshot initiative, with its meticulously planned step-by-step approach to reach the Alpha Centauri system, exemplifies this bold new era of interstellar pursuit.

The importance of such missions extends far beyond merely "getting there." They represent a unique opportunity for unparalleled scientific discovery, particularly in the realm of exoplanet characterization and understanding planetary formation beyond our solar system. Moreover, the immense engineering challenges involved serve as powerful drivers for technological innovation, with potential benefits for all aspects of space exploration and terrestrial applications. Ultimately, journeying to Alpha Centauri is a testament to humanity's unyielding curiosity and its long-term vision for a future amongst the stars. While the challenges are formidable and require sustained international collaboration and investment, the scientific impetus and the potential rewards make this one of the most compelling and transformative endeavors of our time.

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அடிப்படை வானவியலை கற்பதில் செயல்முறை வானியல் உபகரணங்களின் பங்கு

10

ம.ஜெகதீஸ்வரன்
வானியல் செயல்பாட்டாளர்
Hands on Astronomy

அறிமுகம்

வானவியல் (Astronomy) என்பது உலகின் மிகப் பழமையான அறிவியல் துறையாகும். இது விண்மீன்கள், கோள்கள், விண்மண்டல அமைப்புகள், நச்சத்திரங்கள் மற்றும் பிரபஞ்ச வளர்ச்சி குறித்து ஆய்வு செய்கின்றது. இத்தகைய அறிவியலைத் தொடக்க நிலை மாணவர்களுக்கு எளிமையாகவும் ஆழமாகவும் கற்பிக்க **செயல்முறை உபகரணங்கள்** மிக முக்கிய பங்கு வகிக்கின்றன.

செயல்முறை (Hands-on) வானவியல் என்பது கண்காணிப்பு, மாதிரிகள், மேம்பட்ட கருவிகள், மற்றும் விண்வெளி மென்பொருள்களை பயன்படுத்தி நேரடி கற்றலை ஊக்குவிக்கும் பயிற்சி முறையாகும். இது வானவியல் பற்றிய புரிதலை ஆழமாக்க மட்டுமல்ல, மாணவர்களில் ஆர்வம், சிந்தனை திறன் மற்றும் அறிவியல் ஆராய்ச்சிக்கான எண்ணங்களை வளர்க்கிறது.

1. செயல்முறை வானியல் உபகரணங்கள் என்றால் என்ன?

செயல்முறை வானியல் உபகரணங்கள் என்பது மாணவர்கள் நேரடியாக தொடக்கூடிய, இயக்கக்கூடிய மற்றும் காணக்கூடிய கருவிகளை குறிக்கின்றன. இதில் அடங்கும்:

- **தொலைநோக்கிகள் (Telescopes):** விண்மீன்கள், நிலா, கோள்கள் போன்றவற்றை நேரடியாக காண உதவுகின்றன.
- **சூரிய குடும்ப மாதிரிகள் (Solar System Models) :** சூரியனைச் சுற்றி கிரகங்கள் எப்படி சுழல்கின்றன என்பதை விளக்கும்.
- **விண்மீன் வரைபடங்கள் (Star Charts) :** வானத்தில் உள்ள நட்சத்திரங்கள், நட்சத்திரக்கூட்டங்கள் ஆகியவற்றை அடையாளம் காண உதவும்.
- **மென்பொருள் கருவிகள் (Software Tools):** Stellarium, Sky Safari போன்ற வானவியல் பயன்பாடுகள் வானத்தின் இயக்கத்தைக் கண்காணிக்க உதவும்.

2. அடிப்படை வானவியல் கற்றலில் Hands-on உபகரணங்களின் பங்கு

a) பார்வை அனுபவத்தின் மூலம் புரிதல் - **Understanding through visual experience**

வானவியல் என்பது கற்பனைவாதம் மட்டும் அல்ல. தொலைநோக்கி மற்றும் விண்மீன் வரைபடங்கள் பயன்படுத்துவதன் மூலம் மாணவர்கள் நேரடியாக வானத்தைப் பார்வையிட்டு உண்மையை அனுபவிக்க முடிகிறது. இது புத்தகக் கற்றலைவிட ஆழமான புரிதலை உருவாக்குகிறது.

b) சிந்தனையைத் தூண்டும் கற்றல் - **Thought-provoking learning**

தொலைநோக்கி மூலமாக நிலாவின் பரிமாணங்கள், கிரகங்களின் இயக்கம், நட்சத்திரங்களின் தோற்றம் போன்றவை புரிந்து கொள்ளப்படுகின்றன. இது மாணவர்களின் பகுத்தறியும் திறனை மேம்படுத்துகிறது.

c) ஆர்வம் மற்றும் ஆராய்ச்சி மனப்பாங்கு வளர்ப்பு - **Cultivating curiosity and a research mindset**

மாணவர்கள் சுயமாக வானத்தை நோக்கிப் பார்த்து, கேள்விகள் எழுப்பி, அதற்கான பதில்களைத் தேடும் ஒரு ஆராய்ச்சி முறை உருவாகிறது. இது அறிவியல் மனப்பாங்கை ஊக்குவிக்கிறது.

d) குழு வேலை மற்றும் செயல் திறன் வளர்ச்சி - **Teamwork and action skills development**

செயல்முறை பயிற்சிகள் பெரும்பாலும் குழுக்களாக நடைபெறுவதால், மாணவர்கள் ஒருவருடன் ஒருவர் விவாதித்து, கருத்துகளை பகிர்ந்து, குழு உழைப்பைச் செய்முறை வழியில் கற்றுக்கொள்கிறார்கள்.

3. வகுப்பறை நடவடிக்கைகளில் Hands-on Astronomy பயன்பாடு

வானவியல் பக்கவழி (As a side course) பாடமாக இருக்கலாம், ஆனால் அதன் தாக்கம் மிகவும் ஆழமானது. வகுப்பறை மற்றும் பாடத் திட்டங்களில் கீழ்காணும் வகையில் சேர்க்கலாம்:

நடவடிக்கை	உபகரணம்	பயன்
நிலா/கிரகங்களை காண்பது	தொலைநோக்கி	நேரடி பார்வை அனுபவம்
சூரிய குடும்பம் உருவாக்கம்	மாடல் பொருட்கள்	இயக்கத்தை உணர்த்துதல்
நட்சத்திர வரைபடக் கண்காட்சி	Star Charts	வானத் திசைகள் அறிவு
Stellarium பயன்பாடு	கணினி/மொபைல் App	நேர்த்தியான கண்காணிப்பு

4. நன்மைகள்

1. **கற்றல் ஈடுபாடு அதிகரிக்கும்** : நேரடி உபகரணங்களின் பயன்பாடு மாணவர்களின் ஆர்வத்தை தூண்டுகிறது.

2. **அனுபவ அடிப்படையிலான கற்றல்** : உணர்ச்சி மற்றும் அறிவு ஒருங்கிணைந்த கற்றல் ஏற்படுகிறது.

3. **அறிவியல் திறன்கள் மேம்பாடு** : பகுத்தறிவு, காரணம் காண்பது, கண்காணிப்பு, குழு வேலை ஆகிய திறன்கள் மேம்படுகின்றன.

4. **தொழில்நுட்பம் தொடர்புடைய கற்றல்** : வானவியல் Apps மற்றும் மென்பொருட்கள் மூலமாக தொழில்நுட்பக் கற்றல் ஏற்படுகிறது.

5. சவால்கள் மற்றும் பரிந்துரைகள்

சவால்	பரிந்துரை
உபகரணங்களின் விலை அதிகம்	பள்ளி அல்லது அரசு சார்பில் பொது வசதிகள் ஏற்படுத்தலாம்
பயிற்சியுள்ள ஆசிரியர்கள் பற்றாக்குறை	வானியல் பயிற்சி பட்டறைகள் நடத்தியிடல்
மாணவர் செறிவு காரணமாக குறைவான நேரம்	குழு செயல்பாடுகள் மூலம் நேரம் நிர்வகித்தல்

முடிவுரை

வானவியல் என்பது மாணவர்களின் அறிவு மற்றும் சிந்தனை வட்டத்தை விரிவுபடுத்தும் ஒரு விசித்திரமான துறை. இதனை தொடக்க நிலையிலேயே மாணவர்களுக்கு செய்முறை பயிற்சியுடன் கற்றுக் கொடுத்தால், அவர்களில் ஆராய்ச்சி ஆர்வம், அறிவியல் மனப்பாங்கு மற்றும் தன்னம்பிக்கை ஆகியவை உருவாகின்றன. **Hands-on Astronomy** உபகரணங்கள் மூலம் இந்த அறிவியல் பயணம் சிறப்பாக அமையும்.

அதனால், வகுப்பறை மட்டுமல்லாது புலமையறிவுக் கூடங்களிலும், விழிப்புணர்வு நிகழ்ச்சிகளிலும், வானவியல் முகாம்களிலும் இந்த செயல்முறை உபகரணங்கள் பரவலாக பயன்படுத்தப்பட வேண்டும். இது அறிவியல் ஆர்வமுள்ள தலைமுறையை உருவாக்கும் ஒரு சிறந்த முதலீடு ஆகும்.

Appendix 2

Model Poster Presentations

These model posters are provided solely for reference purposes. They serve to enhance understanding of research methodology and to illustrate effective poster presentation techniques.

REACHING FOR THE STARS: JOURNEY TO ALPHA CENTAURI

D.Khanna and P.Malin Bruntha, Karunya Institute of Technology and Sciences, Coimbatore

INTRODUCTION

- For decades, interstellar travel was confined to science fiction.
- Now, with innovative concepts like laser-powered nanosail satellites, reaching the closest star system, Alpha Centauri, within a human lifetime is becoming a tangible possibility.

OBJECTIVE

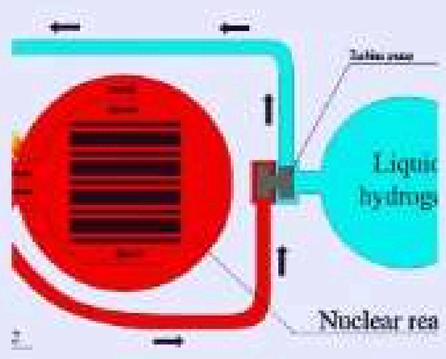
- This poster explores the fascinating journey and the technology making a trip to a star possible.

TRAVELING TO STARS: CONCEPTS

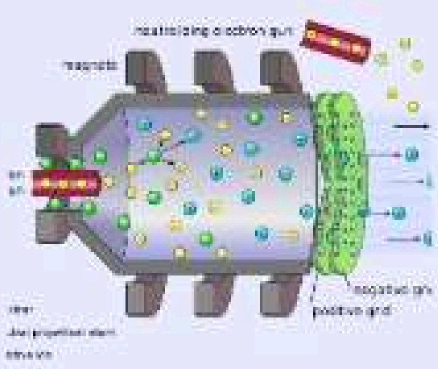
Several concepts for interstellar travel have been proposed, each with its own challenges:

- Chemical Rockets: Current technology, but too slow for interstellar distances.
- Nuclear Propulsion: Offers higher speeds but faces safety and political concerns.
- Ion Drives: Highly efficient but provide very low thrust, requiring long periods to accelerate.
- Solar Sails: Use sunlight for propulsion, effective within the solar system, but less effective at interstellar distances.
- Laser-Powered Nanosails: Harness the power of focused lasers to propel lightweight sails to a significant fraction of the speed of light. This is the focus of the Breakthrough Starshot initiative.
- Matter-Antimatter Propulsion: This highly theoretical concept involves annihilating matter and antimatter to convert nearly 100% of their mass into pure energy

Chemical Rockets



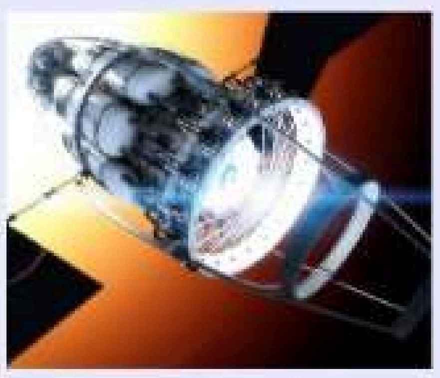
Nuclear Propulsion



Ion Drives

Solar Sails

Laser-Powered Nanosails

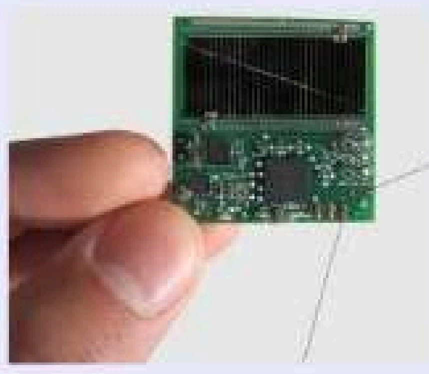


Matter-Antimatter Propulsion

TRAVELLING TO ALPHA CENTAURI

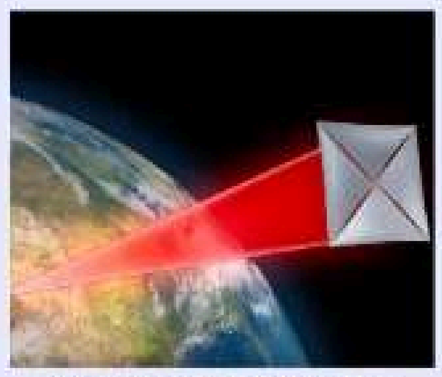
The Breakthrough Starshot initiative proposes a revolutionary five-step mission to reach our nearest stellar neighbor:

1. Micro-Probe Assembly: Develop and assemble gram-scale StarChips attached to ultra-thin lightsails for maximum reflectivity.
2. Gigawatt Laser Array: Construct an immense ground-based laser array capable of generating up to 100 gigawatts of power.
3. Rapid Relativistic Acceleration: Launch and accelerate the nano-sail space probes with the use the powerful laser array. (20% light speed)
4. Interstellar Cruise: The accelerated micro-probes embark on a long interstellar journey, reaching the Alpha Centauri in 20-30 years.
5. Data Collection & Transmission: Upon arrival, the probes collects vital scientific data and images and transmit them within 5 years.

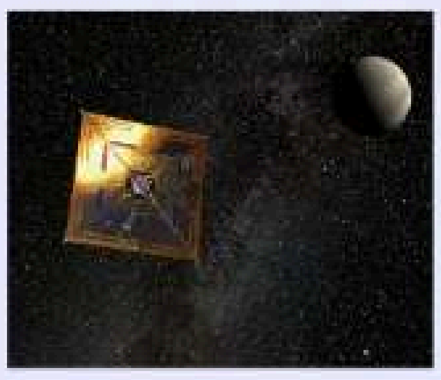


Micro-Probe Assembly

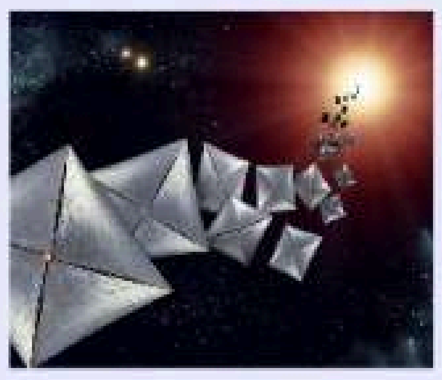
Gigawatt Laser Array



Relativistic Acceleration



Interstellar Cruise



Data Collection & Transmission

WHY GO TO A STAR SYSTEM?

- Proxima b: Studying Proxima Centauri b in detail could reveal insights into the potential for life beyond Earth.
- Understanding Planetary Systems: Visiting another star system allows us to study planetary formation and evolution in a different context.
- Technological Advancement: The challenges of interstellar travel drive innovation in lasers, materials science, and nanotechnology.
- Humanity's Future: Reaching other stars is a fundamental step in expanding humanity's presence in the universe.

CONCLUSION

- Laser-powered nanosail technology, spearheaded by projects like Breakthrough Starshot, offers a revolutionary approach to interstellar travel.
- While significant technological hurdles remain, the potential rewards – from discovering new worlds to expanding our understanding of the cosmos – make the journey to Alpha Centauri a compelling and worthwhile endeavor.

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METEORITES - THE COSMIC FIREBALLS

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INTRODUCTION

- Our Solar System is a dynamic place, constantly sending us messages.
- These messages arrive as space rocks that fall to Earth - meteorites!
- They are cosmic time capsules, holding clues about the universe's past.

WHAT IS A METEORITE?

- A meteorite is a piece of rock or metal that has fallen to Earth from space.
- It survived a fiery journey through our atmosphere and landed on the surface.
- These are incredibly rare and valuable samples from beyond our planet!

METEOROID, METEOR, METEORITE: WHAT'S THE DIFFERENCE?

- Meteoroid: A small rocky or metallic body traveling through space, before it enters Earth's atmosphere.
- (Think of it as a space rock in space).
- Meteor: The streak of light we see when a meteoroid burns up upon entering Earth's atmosphere. This is commonly called a "shooting star."
- (Think of it as the space rock burning in the sky).
- Meteorite: What's left of the meteoroid after it survives entry and hits Earth's surface.
- (Think of it as the space rock that landed).

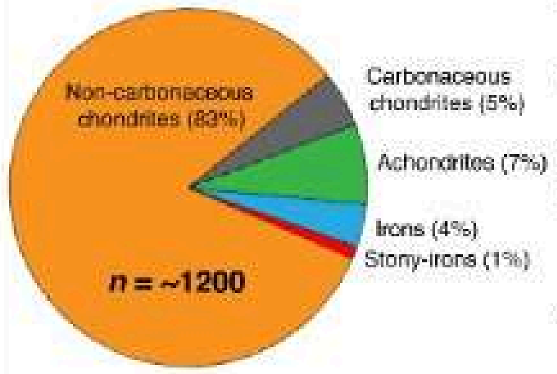
OBJECTIVE

- This poster aims to introduce the fascinating world of meteorites: their origins, different types, and why scientists study them.
- This poster aims to show how these special space rocks help in understanding the Solar System's history and formation.

CLASSIFICATIONS: TYPES OF METEORITES

Meteorites are classified based on their composition, giving us clues about their parent bodies:

- Stony Meteorites (Most Common):
  - Chondrites: Primitive, unmelted rocks containing tiny spheres called chondrules. They are like original building blocks of planets, offering insights into the early Solar System.
  - (Example: Our early solar system's "original dust").
  - Achondrites: Formed from melted asteroids or planets (like Mars/Moon), showing igneous textures.
  - (Example: Volcanic rocks from small planets).



- Iron Meteorites:
  - Almost entirely made of iron-nickel metal, often from the cores of shattered asteroids.
  - (Example: Core material from a broken-up mini-planet).
- Stony-Iron Meteorites:
  - A rare mix of metal and stony material, thought to come from the boundary between an asteroid's core and mantle.
  - (Example: Where the core meets the rock inside an asteroid).

IMPORTANT FINDINGS SO FAR

Meteorites are cosmic detectives! Research on them has revealed:

- Origin of Earth's Water: Some primitive meteorites (carbonaceous chondrites) contain water and organic molecules, suggesting they might have delivered crucial ingredients for life to early Earth. (Vernazza et al., 2020)
- Asteroid Connections: Most meteorites come from the asteroid belt, helping scientists link specific meteorites to their "parent asteroids" and understand asteroid evolution.
- Early Solar System Chemistry: They preserve the chemistry of the nebula that formed our Sun and planets, acting as untouched samples of our cosmic beginning.
- Planetary Building Blocks: By studying their composition, we learn how planets like Earth assembled from smaller bodies.

STONY METEORITES: CHONDRITES

STONY METEORITES: ACHONDRITES

IRON METEORITES

STONY - IRON METEORITES

A SIGNIFICANT EVENT: THE CHELYABINSK METEORITE (2013)

- On February 15, 2013, a meteoroid exploded over Chelyabinsk, Russia, producing a bright flash and a shockwave.
- Fragments of this object landed as meteorites.
- Scientists studied these fragments, confirming it was a piece of an S-type asteroid and helping us understand how larger space rocks break up in our atmosphere.
- This event highlighted the importance of detecting Near-Earth Objects. (Sanborn et al., 2018)

TIMINGS TO WATCH A METEOR SHOWER (METEOR EVENT)

- One can see "shooting stars" (meteors) when Earth passes through debris trails left by comets or asteroids. These are called meteor showers.
- Look up at night: Best seen far from city lights.
- Key Showers (Check local astronomy calendars for exact peaks!):
- Perseids: Mid-August (from Comet Swift-Tuttle)
- Geminids: Mid-December (from Asteroid 3200 Phaethon)
- Leonids: Mid-November (from Comet Tempel-Tuttle)

CONCLUSION

- Meteorites are more than just space rocks; they are messengers from the dawn of our Solar System.
- By collecting and studying them, we piece together the cosmic puzzle of our origins, unlock secrets of planetary formation, and prepare for future space exploration.
- Every meteorite tells an incredible story!

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Appendix 3

FOCAL THEME
&
SUB THEMES

Focal Theme

The New Space Age: Bridging Science, Technology & Society

Sub-Themes

1. Our Cosmic Neighbourhood
The Solar System: Exploration & Discoveries (2010 –present)

2. A. Stellar Physics (2010 – present)
B. High-Energy Astrophysical Events (2010 – present)

3. Exoplanets & the Science of Habitability (1992 – present)

4. Emerging Space Technologies & Indigenous Launch Capabilities (2010 – present)

5. Mathematical Modelling & Computational Tools in Astronomical Research (2010 – present)

6. Astronomy Education, Citizen Science & Science Communication in India

Sub-Theme -1

1. Our Cosmic Neighbourhood – The Solar System: Exploration & Discoveries (2010 –present)

1. Earth's Moon: The Lunar Renaissance

- ISRO (Chandrayaan Program): Chandrayaan-2 (2019–Present); Candrayaan-3 (2023)
- CNSA (Chang'e Program): Chang'e 3 & 4 (2013, 2019); Chang'e 5 & 6 (2020, 2024)
- NASA (LRO & Artemis): Lunar Reconnaissance Orbiter; Artemis I (2022); Artemis II (2026)

2. The Sun: Heliophysics and Solar Dynamics

- NASA (Parker Solar Probe, 2018–Present): Touching the Sun
- ESA/NASA (Solar Orbiter, 2020–Present):
- ISRO (Aditya-L1, 2023–Present)

3. Inner Planets: Mercury & Venus

- NASA (MESSENGER, 2011–2015):Mercury
- JAXA (Akatsuki, 2015–Present): Venus

4. Mars: The Search for Ancient Habitability

- NASA (Curiosity, InSight, Perseverance): Curiosity (2012); InSight (2018–2022); Perseverance & Ingenuity (2021–Present):
- ISRO (Mangalyaan / Mars Orbiter Mission, 2014–2022):
- CNSA (Tianwen-1 & Zhurong, 2021):
- UAE Space Agency (Hope Probe, 2021–Present)

5. Small Bodies: Asteroids, Comets & Planetary Defense

- JAXA (Hayabusa & Hayabusa2, 2010, 2020):
- NASA (OSIRIS-REx & DART): OSIRIS-REx (2023); DART Mission (2022); NASA (Dawn, 2011–2018)
- ESA (Rosetta & Philae, 2014–2016)

6. The Outer Solar System: Gas Giants & Ice Giants

- NASA (Juno, 2016–Present): Jupiter
- NASA/ESA/ASI (Cassini-Huygens, 2010–2017): Saturn
- NASA (New Horizons, 2015, 2019): Pluto and Kuiper Belt Objects

7. The James Webb Space Telescope (JWST Solar System Observations, 2022–Present)

Sub-Theme -2

2. A. Stellar Physics (2010 – present)

1. The Stellar Lifecycle & Asteroseismology (Starquakes)

- ESA (Gaia, 2013–Present)
- NASA (Kepler/K2 & TESS, 2010–Present)

2. Neutron Stars, Pulsars & Magnetars

- ISRO (AstroSat, 2015–Present)
- Giant Metrewave Radio Telescope (GMRT), Pune
- NASA (NICER, 2017–Present)
- ISRO (XPoSat, 2024–Present)
- CNSA/CAS (Insight-HXMT, 2017–Present)

3. Black Holes & X-Ray Binaries (Microquasars)

- NASA/ASI (IXPE, 2021–Present)
- JAXA (MAXI, 2010–Present)

2. B. High-Energy Astrophysical Events (2010 – present)

1. Supernovae & Stellar Demise (Core-Collapse)

- NASA (NuSTAR, 2012–Present)
- NASA/ESA/CSA (JWST, 2022–Present)
- JAXA/NASA (XRISM, 2023–Present)

2. Gamma-Ray Bursts (GRBs) & Kilonovae

- Multi-Agency Triumph (GW170817 Kilonova, 2017): The LIGO/Virgo gravitational wave observatories
- NASA's Fermi and ESA's INTEGRAL space telescopes.
- Global Effort (The B.O.A.T. - GRB 221009A, 2022): Fermi, Swift, and Insight-HXMT.

Sub-Theme -3

3. Exoplanets & the Science of Habitability (1992 – present)

1. Indirect Detection Technologies (Measuring Stellar Influence)

- **Transit Photometry (The Primary Workhorse):**
- **Radial Velocity / Doppler Spectroscopy: HARPS (High Accuracy Radial velocity Planet Searcher) at La Silla Observatory, ESPRESSO at the VLT.**
- **Gravitational Microlensing: OGLE (Optical Gravitational Lensing Experiment), MOA (Microlensing Observations in Astrophysics).**
- **Pulsar Timing Array:**
- **Astrometry: The ESA Gaia mission.**

2. Direct Detection Technologies

- **(Direct Imaging): Starshade Mission (Proposed).**
- **Ground-Based Adaptive Optics: The Very Large Telescope (VLT) in Chile, the Keck Observatory in Hawaii, and the Gemini Observatory.**

3. Dedicated Space Missions & Observatories (1992–Present)

- **The Pioneers: CoRoT (ESA, 2006–2013)**
- **The Revolution: Kepler Space Telescope (NASA, 2009–2013); K2 Mission (NASA, 2014–2018)**
- **The Modern Era: TESS - Transiting Exoplanet Survey Satellite (NASA, 2018–Present); CHEOPS (ESA, 2019–Present)**
- **Atmospheric Characterization: Hubble & Spitzer Space Telescopes; JWST - James Webb Space Telescope (NASA/ESA/CSA, 2022–Present)**

4. The Science of Habitability & Atmospheric Characterization

- **The Circumstellar Habitable Zone (CHZ)**
- **Transmission Spectroscopy**
- **M-Dwarf Habitability Challenges**
- **Biosignatures vs. Abiotic Processes**

Sub-Theme -4

4. Emerging Space Technologies & Indigenous Launch Capabilities (2010 – present)

1. Reusable Launch Vehicles (RLVs) & Autonomous Landing Systems

- Vertical Takeoff, Vertical Landing (VTVL) Dynamics: SpaceX Falcon 9/Heavy boosters, Blue Origin New Shepard
- Winged Reusable Testbeds: ISRO's RLV-TD / Pushpak missions, ESA's Space Rider
- Mid-Air Recovery Systems: Rocket Lab's Electron recovery
- Project Ideas for Students: Simulating descent trajectories; Designing shock-absorbing landing legs; Developing AI-based optical navigation for pinpoint autonomous landings.

2. Next-Generation & "Green" Propulsion Systems·Electric & Ion Propulsion: Starlink's krypton/argon thrusters, ISRO's Electric Propulsion System EPS

- Green Chemical Propellants: Non-toxic monopropellants (like LMP-103S or ASCENT); Advanced bipropellants (Methalox – liquid methane and liquid oxygen); ISRO's developing Methalox engines).
- 3D-Printed Rocket Engines: Agnikul Cosmos's Agnilet engine, the world's first single-piece 3D-printed semi-cryogenic rocket engine).
- Project Ideas for Students: Designing micro-thrusters for CubeSats; Testing new nozzle geometries for 3D printing; Simulating the efficiency of plasma-based propulsion.

3. The Small Satellite Revolution: CubeSats & Constellations

- Micro/Nano-Satellite Architectures
- Mega-Constellations & Swarm Intelligence: Starlink, OneWeb
- Dedicated Small Satellite Launchers: ISRO's SSLV - Small Satellite Launch Vehicle, Skyroot Aerospace's Vikram-S
- Project Ideas for Students: Designing a 1U CubeSat payload for environmental monitoring; Proposing a constellation topology for disaster management in Tamil Nadu or India; Developing deployable solar panel mechanisms for micro-satellites.

4. In-Orbit Servicing, Assembly, and Manufacturing (ISAM)

- Autonomous Docking & Space Tugs: ISRO's SPADEX - Space Docking Experiment
- Active Space Debris Removal (ADR): Harpoons, robotic arms, magnetic tethers, and drag sails like ISRO's POEM orbital platform experiments
- In-Space Manufacturing
- Project Ideas for Students: Simulating robotic arm kinematics for catching tumbling debris; Designing lightweight drag-sails for end-of-life satellite disposal; Proposing collision-avoidance algorithms.

5. Advanced Spacecraft Avionics & "Edge AI"

- Software-Defined Radios (SDR) & Satellites
- AI for Earth Observation (Edge Computing): Indian startup Pixxel's hyperspectral imaging satellites
- Advanced Star Trackers & Navigation
- Project Ideas for Students: Training a machine learning model to detect forest fires from raw satellite imagery; Training a machine learning model to detect floods from raw satellite imagery; Designing a low-power, radiation-hardened microcontroller architecture for CubeSats.

6. Indigenous Space Ecosystems & Private Startups (Developing Nations)

- India's Private Space Sector: Under IN-SPACe: Skyroot Aerospace, Agnikul Cosmos, Bellatrix Aerospace, Dhruva Space
- Emerging Space Nations: African and Latin American nations (e.g., Kenya's Taifa-1, launched in 2023).
- Project Ideas for Students: Conducting a feasibility study on establishing a commercial launch pad in southern India (like the Kulasekharapatnam spaceport); A policy framework for integrating private university research with ISRO missions.

Sub-Theme -5

5. Mathematical Modelling & Computational Tools in Astronomical Research (2010 – present)

1. Differential Equations & Orbital Dynamics (N-body Simulations)

- Mathematical Focus: Ordinary and Partial Differential Equations (ODEs & PDEs), Symplectic Integrators, Runge-Kutta methods (RK4).
- Astronomical Applications: Simulating the long-term stability of the Solar System or newly discovered exoplanet systems; Trajectory optimization for spacecraft
- Project Idea for Students: Use a numerical integrator in Python to solve the restricted three-body problem.

2. Numerical Methods & Hydrodynamics

- Mathematical Focus: Finite Difference, Finite Volume, and Finite Element Methods; Navier-Stokes equations; Magnetohydrodynamics (MHD).
- Astronomical Applications: Modeling the interior convective zones of stars; Simulating the shockwaves of supernovae expanding into the interstellar medium.
- Project Idea for Students: Develop a 1D computational fluid dynamics (CFD) simulation using finite difference methods to model the propagation of a blast wave (supernova simulation) through a uniform gas density, tracking pressure, temperature, and velocity over time.

3. Signal Processing & Fourier Analysis

- Mathematical Focus: Fast Fourier Transforms (FFT), Wavelet Analysis, Cross-Correlation, Matched Filtering.
- Astronomical Applications: Radio Interferometry: Combining signals from multiple radio dishes (like the upcoming Square Kilometre Array); Pulsar Timing: Using FFTs to find the hidden periodic signals of rapidly spinning neutron stars in noisy radio data; Gravitational Waves: Using matched filtering to find the exact "chirp" signature of merging neutron stars within the noisy data streams of LIGO and Virgo.
- Project Idea for Students: Download raw, noisy light-curve data from the Kepler or TESS archives. Apply a Fast Fourier Transform algorithm to "clean" the data, filter out stellar noise, and successfully isolate the periodic dip of a transiting exoplanet.

4. Statistical Inference & Bayesian Astrostatistics

- Mathematical Focus: Bayesian Inference, Markov Chain Monte Carlo (MCMC) algorithms, Gaussian Processes, Chi-Square minimization.
- Astronomical Applications: Estimating the exact mass and radius of an exoplanet based on radial velocity data; Determining the age of a star cluster by statistically fitting isochrone models to a scatter plot of its stars on a Hertzsprung-Russell diagram.
- Project Idea for Students: Write an MCMC algorithm to fit a theoretical mathematical curve to a set of real, scattered astronomical data (e.g., a star's radial velocity over time).

·5. Machine Learning & Big Data (Astroinformatics)

- Mathematical Focus: Convolutional Neural Networks (CNNs), Principal Component Analysis (PCA), Random Forests, Support Vector Machines (SVM).
- Astronomical Applications: Automated classification of stellar spectra (O, B, A, F, G, K, M types); Real-time anomaly detection to spot supernovae, tidal disruption events, or gamma-ray bursts moments after they happen in sky surveys.
- Project Idea for Students: Train a standard Convolutional Neural Network (CNN) using publicly available databases (like the Sloan Digital Sky Survey). The student's model should be able to automatically ingest raw spectral data and accurately classify whether the object is a main-sequence star, a white dwarf, or a quasar.

6. Industry-Standard Computational Frameworks

- Astropy: The core Python library for astronomy (handles celestial coordinates, FITS image files, and cosmological calculations).
- MESA (Modules for Experiments in Stellar Astrophysics): A powerful open-source suite for 1D stellar evolution. Students can simulate the entire life cycle of a star from a molecular cloud to a white dwarf.

Sub-Theme -6

6. Astronomy Education, Citizen Science & Science Communication in India

1. Citizen Science: Democratizing Astronomical Research

- **The RAD@home Indian Collaboratory: Data from the Giant Metrewave Radio Telescope (GMRT) in Pune**
- **Asteroid Search Campaigns (IASC): To analyze Pan-STARRS data**
- **Project Ideas for Students:**
- **Form an official search team, participate in a verified citizen science campaign, and present a paper documenting the methodology of identifying true near-Earth objects versus false visual signatures.**
- **Analyze data from the RAD@home database and present a case study on a specific active galactic nucleus (AGN) feedback mechanism.**

2. Astronomy Education & Curriculum Analysis

- **NCERT & UGC Curriculum Gaps: Practical observational astronomy.**
- **Vernacular Science Communication: For rural students in regional languages.·Importance of hands-on-activities and models: For school teachers·Project Ideas for Students:**
- **Analyze the current physics curriculum and propose a structured, low-cost practical astrophysics module.**
- **Develop a vernacular science communication portfolio – translating high-level space science terminology into Tamil to aid rural outreach for grassroots organizations like the Tamil Nadu Astro and Science Society (TASS).**
- **Design and build low-cost models and hands-on-activities using only locally sourced materials, along with teaching manual of astronomy for high school teachers.**

3. Dark Sky Awareness & Astro-Tourism in India

- **The Hanle Dark Sky Reserve (HDSR)**
- **Light Management Plans**
- **Project Ideas for Students:**
- **Conduct a localized light pollution study (Bortle scale mapping) comparing an urban center like Coimbatore with a high-altitude observational site like the Kodaikanal Solar Observatory.**
- **Draft a comprehensive socio-economic and scientific proposal for establishing a "Dark Sky Park" in the Western Ghats, modelling it strictly after the community-engagement framework of the HDSR.**

4. Indigenous Astronomical Heritage (Archaeoastronomy)

- **Siddhantic Astronomy & The Kerala School:**
- **Folk Astronomy & Regional Literature:**
- **Project Ideas for Students:**
- **Mathematically decode a specific planetary algorithm used in the Surya Siddhanta and run a computational comparison against modern predictive models to determine its margin of error.**
- **Conduct a literature review of ancient Tamil Sangam texts to catalog specific references to planetary motions, constellations (Nakshatras), and maritime celestial navigation.**
- **Research the architectural alignments of local historical or megalithic sites to prove intentional solstitial or equinoctial alignments.**

YOUTH ASTRONOMY & SPACE SCIENCE CONGRESS

YASSC 2026

Organised by

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In association with