Rochester Academy of Science

BULLETIN

"An organization of people in the Natural Sciences"

December 2021; Vol. 75, #9

President's Message

I was thrilled to be at the annual Fall Scientific Paper Session all day Saturday, November 6th. In this challenging year for colleges as well as for the rest of us, we saw significant differences from our past programs. As expected, this event was smaller by about half from recent years. We had 50 posters and 12 oral presentations, with 175 attendees from 18 Upstate New York colleges and universities. In addition to the local colleges, we had students and faculty from Buffalo, Ithaca and Oswego. We also had students from faraway St. Bonaventure University (208 miles round-trip) and even farther Jamestown Community College (284 miles round-trip).

For most past Paper Sessions, we provided the specifications and oversight and the host college provided all the resources and runs the program. This year, colleges were stressed just to run basic programs. Nazareth College offered space, but very limited resources. That left the RAS to run every detail of the program, with the help of a few volunteer friends at Nazareth. We accomplished it all. Thanks again to all our volunteers. The Paper Session founders, professors Larry King and Melvin Wentland, would be proud! You will see articles in the next few bulletins celebrating a few of the research projects presented.

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Unusual Outreach

Part of our mission is to provide our members with a means to study and learn more about the natural sciences, particularly those of most interest to them. Another part is in promoting science through various outreach programs to draw in other members of the community. We do this through publicly available lectures, observatory open houses, and hands-on displays and activities at community events, such as Rochester Museum & Science Center programs, Monroe County's WinterFest, ADK Outdoor Expo, Science Exploration Days, and others.

Out of the ordinary was a theatrical production last month. I congratulate our ASRAS members who had a hand in the recent Blackfriars Theatre presentation of the play "Silent Sky" – theatre stage manager Jackie Amigone and Patrick Cosgrove who provided 20 outstanding astronomical photographs for the production to use as backdrops. Well done!

The play is about Henrietta Swan Leavitt, who lived from 1868 – 1921. She was an astronomer who opened the door to a dramatic enlargement in the size of the known universe. She found that a certain type of star, the Cepheid variable, pulses at a rate that's related to its brightness.

Henrietta Swan Leavitt

A Cepheid variable star's pulse rate reveals the star's true, fundamental brightness. The amount by which the star's brightness is dimmed by distance allows the star's distance from the earth to be calculated. Her work had to overcome soul-crushing marginalization of women in science at the time and was pivotal to Edwin Hubble's discovery that the universe is much bigger than just the Milky Way and also that our own galaxy is but one of many. This and more is at www.famousscientists.org.

Messier 42 - The Great Orion Nebula, a favorite of Patrick Cosgrove, as seen at "Silent Sky." See this in large form as well as other great astronomical photos at his website, cosgrovescosmos.com/

Other Outreach in the past month included Mineral Section (Jutta & Paul Dudley, Fred Haynes, and Brian McGrath) at the annual Science Teachers Association of New York State conference, at which Michael Richmond (ASRAS) was a keynote speaker on the Perseverance Mars rover and mission. Our Anthropology Section (Alex Smith, Karen Wolfe, & I) also delivered Archeology Day programs at RMSC.

Best wishes for an active and happy 2022!

Michael Grenier, President RAS

RAS Membership Renewal

Use this temporary link

https://rochesteracademyofscience.godaddysites.com/how-to-join

Events for December 2021

For updates to events, check the Academy website http://www.rasny.org and section websites.

NOT MEETING IN DECEMBER
Mineral section
Life Sciences
Herbarium
RAS Board

1 Wed: Astronomy Board Meeting

7:00 p.m. UR Bausch & Lomb Hall, room 480. ASRAS members welcome. Contact: Mark Minarich at mminaric@rochester.rr.com.

3 Fri: Astronomy Meeting and Holiday Extravaganza

6:30 p.m. – 10:00 p.m. Strasenburgh Planetarium. Masks and vaccination required. Schedule of events:
6:30p.m.-7:30 p.m. snacks served.
7:30 p.m. - 8:00 p.m. ASRAS business meeting.
8:00 p.m. – 8:45 p.m. featured speaker: Dan Schneiderman, RMSC Eclipse Coordinator: "Planning for the April 8, 2024 Eclipse".
8:45 p.m. - 9:15 p.m. Member Images.
9:15 p.m. – 10:15 p.m. Black Holes revealed and Highlights of 2022 in Astronomy. We will attempt to stream the meeting portion of this event.
There is an attendance limit of 100 people in the Planetarium; please make an email reservation before Dec 2, 2021 with Eric Day, x10automation@gmail.com. For further information contact Mark Minarich at mminaric@rochester.rr.com.

4 Sat: Astronomy Member Observing

Member Observing: Starting from dusk till last person leaves. Farash Center for Observational Astronomy, 8355 County Road 14 Ionia, NY 14475. For weather related cancellations or changes contact Mark Minarich at mminaric@rochester.rr.com.

5 Sun: Astronomy Open House

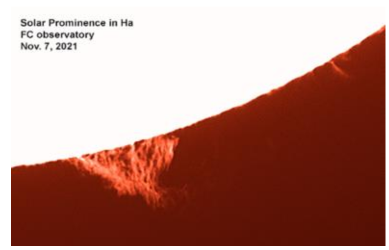
Open House: 12:00 p.m. - 3:00 p.m. Observatory tours and work parties. Sledding if snow. Indoors at normal capacity for those already vaccinated, otherwise masks and social distancing or outdoors only. Farash Center for Observational Astronomy, 8355 County Road 14 Ionia, NY 14475. For weather related cancellations or changes contact Roger McDonough, site manager, at rdmcdogz@aol.com.

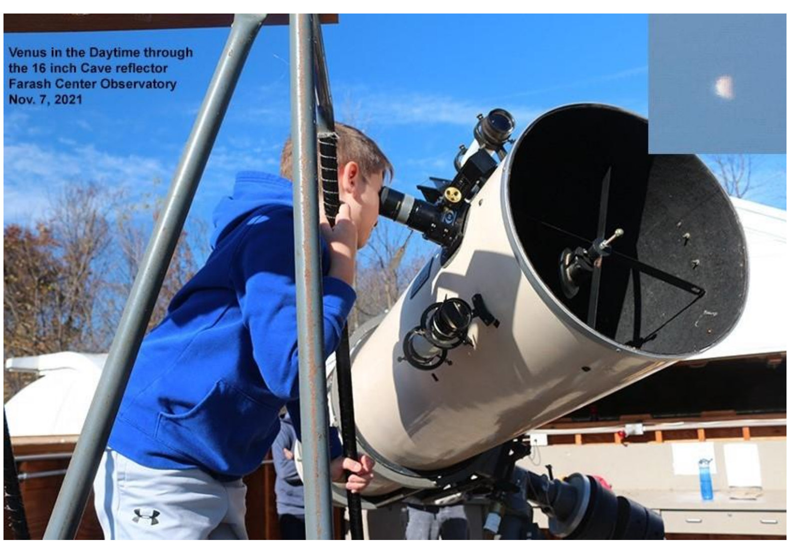
5 Sun: Fossil Section

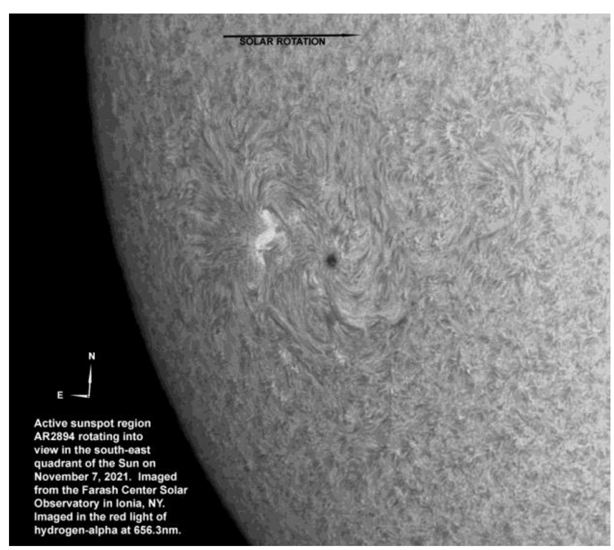
3 p.m. sharp - 5 p.m. Meeting will be held at the Rochester Museum & Science Center. RMSC paleontologist and RAS Fossil member George McIntosh will lead a behind-the-scenes guided tour of the RMSC's newest traveling exhibit, "Expedition: Dinosaur" https://rmsc.org/dinosaurs/. Our group is limited to 12 members and there will be an $8 RMSC charge for admission (normal charge is $20). Members must register in advance – write to paleo@frontier.com. There will be no other meeting this month, this is in lieu of the annual Show & Tell meeting.

ASRAS Open House

Activities at the November 7, 2021 open house at the ASRAS Farash Center for Observational Astronomy campus in Ionia, NY. Solar photos taken at the Solar Observatory with a 100mm Lunt H-alpha telescope mounted side by side with a 130mm TMB refractor telescope in their own roll-off. Bottom left, photo taken at the 16" Cave Newtonian roll-off of a visitor observing Venus in the daytime. Open House Photos courtesy of Bob McGovern. Venus photo courtesy Douglas Kostyk.







Featured 2021 RAS Paper Session Poster

Patrick Stetzel, Rachel Schultz, Ph.D., SUNY Brockport.

A Floristic Quality Assessment of the Cranberry Pond Restoration: Comparing Pre and Post Restoration Data

Abstract

The success of a Great Lakes Coastal Wetland restoration project was evaluated using an ecological assessment tool designed to measure wetland integrity through the collection of vegetative data. The restoration work was performed to reestablish habitat heterogeneity lost to the invasive cattail hybrid, *Typha x glauca*, through the construction of water channels and large open water areas called potholes. Transect surveys were conducted both pre- and post-restoration using Floristic Quality Assessment parameters to measure the change in the wetland plant community. Coefficients of Conservatism, or "C" values, are assigned to individual plant species on a scale from 0-10, with a 10 indicating a species with high fidelity to undisturbed habitats. A weighted mean C metric ($w\bar{C}$) was used for the analysis to account for species' abundance. Using a paired t-test to compare pre and post restoration data, we found a significant increase in $w\bar{C}$ values post-restoration. While there was no significant difference in $w\bar{C}$ between the post-restoration restored and control sites in 2021, there was a 36% decrease in relative abundance for the invasive cattail. This data suggests that there was a preliminary success for the restoration work. Low-water levels and insufficient time for higher fidelity species to establish may account for the lack of contrast between $w\bar{C}$ values in the restored versus unrestored areas. Future plantings to improve habitat heterogeneity and time may show an increase in floristic quality over time, which will be monitored again in 2022.

Author Patrick Stetzel in front his poster at the 47th Annual RAS Fall Paper Session held November 6th at Nazareth College.

Introduction

Invasive species can outcompete native plants for resources, spread quickly, alter food webs and wetland structure, as well as demonstrate the capabilities to degrade or destroy entire native ecosystems. Cranberry Pond is a 90-ha *Typha x glauca* dominated wetland located about 18 km NW of Rochester, NY. *Typha x glauca* is an invasive hybridized plant that can rapidly colonize an ecosystem, significantly reducing biodiversity and availability to resources for native flora and fauna [1]. Restoration work was performed in winter of 2020 to create six potholes and 9 channels to reduce impact of the invasive cattail and restore native habitat (figure 1). Floristic Quality Assessments, developed in the 1970s, are used to assess freshwater wetland integrity and restoration success.

Methods

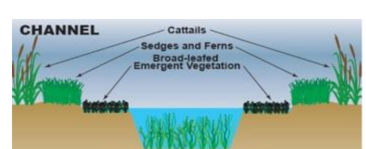
Transect surveys were conducted pre (2019) and post restoration (2021) using Floristic Quality Assessment parameters to measure a change in the wetland's conservation value. Transect surveys included measurements of % living cover, % litter cover, individual species of vascular plants, and their relative cover. In a floristic quality assessment, all plant species are assigned a Coefficient of Conservatism, or "C" value from 0-10 (Swink & Wilhelm 1994 as cited in [3]), with 10 indicating a species with high fidelity to undisturbed habitats.

A Floristic Quality Calculator modified for New York [4] (Chung-

(Continued on p.4)

Figure 1. Map of Cranberry Pond detailing channel and pothole locations (black), transect locations from pre- (dashed lines) and post-restoration (solid lines), and control plots from 2021 (white dots).Green lines indicate transects higher $w\bar{C}$ *values while red lines indicate transects with lower* $w\bar{C}$ *values.*

Left, pre-restoration (2018) and right, post-restoration (2021) photos of channels-potholes dug in Cranberry Pond. Drone images courtesy of Greg Lawrence



Example of a channel dug out by the Army Corps of Engineers.

Patrick Stetzel
(Continued from p. 3)

Gibson 2017) was used to determine a weighted mean C metric (w$\bar{C}$) that removes sample site size bias by accounting for species abundance with the average C-value for plants in a sample [5]. w$\bar{C}$ and species richness were tested for significant statistical differences using: a paired t-test for pre- and post-restoration and an independent t-test for control vs. restored plots in 2021.

<u>Results</u>

We found a 25% increase in w$\bar{C}$ values post-restoration when comparing the paired 2019 and 2021 transect data (Figure 1 and 2, t = 3.441, p=0.003).

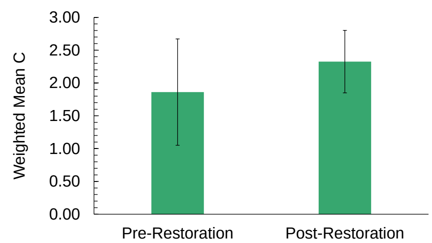


Figure 2: ***w$\bar{C}$*** *values compared using a paired t-test of 2019, pre-restoration data and 2021, post-restoration data at Cranberry Pond in the BBWMA. The pre-restoration* ***w$\bar{C}$*** *showed a significant decrease relative to the post-restoration* ***w$\bar{C}$****. Error bars represent ± one standard error.*

A paired t-test of pre- and post-restoration species richness data revealed that there was also a 135 % increase (Figure 3, t=10.422, p=0).

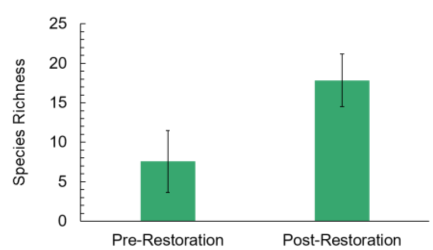


Figure 3: Total species richness compared using a paired t-test with 2019, pre-restoration data and 2021, post-restoration data at Cranberry Pond found in the BBWMA. There was a significant increase in the species richness after the restoration work. Error bars represent ± one standard error.

We determined that there was no significant difference between 2021 w$\bar{C}$ values from control plots and restored plots (Figure 4, t=0.618, p=0.542).

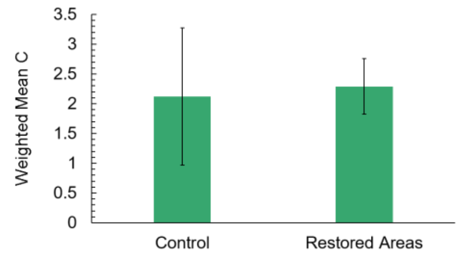


Figure 4: w$\bar{C}$ values (a floristic quality metric) from control plots vs 2021 restored area plots at Cranberry Pond in the BBWMA. The control plots averaged a weighted mean C value of 2.12±1.15 while the restored plots showed a weighted mean C value of 2.29±0.46 Error bars represent ± one standard error.

An independent variable t-test between 2021 control plots and 2021 restored sites revealed that there was a significant difference between the two areas when comparing species richness (Figure 5, t=16.359, p=0).

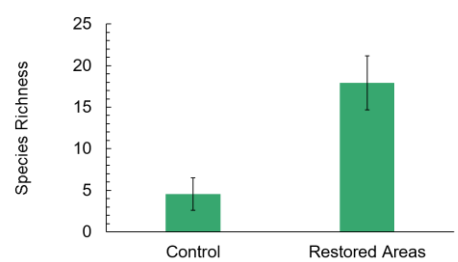


Figure 5: Total species richness compared using an independent variable t-test with 2021 control site and 2021 restoration site data at Cranberry Pond in the BBWMA. The control plots had an average of 4.55±1.93 compared to the restored sites having an increased average overall species richness of 17.91±3.25. Error bars represent ± one standard

There was a 36.37% decrease in relative abundance for Typha x glauca from 2019 to 2021 transect data (Table 1).

Species: Pre-restoration	Common Name	C-Value	Relative % Cover
1. *Typha X glauca*	hybrid cat-tail	1	76.83%
2. *Thelypteris palustris*	eastern marsh fern	4	10.85%
3. *Decodon verticillatus*	swamp loosestrife	7	4.42%
4. *Boehmeria cylindrica*	small-spike false nettle	6	1.33%
5. *Persicaria amphibia*	water smartweed	6	0.86%
Species: Post-restoration			
1. *Typha X glauca*	hybrid cat-tail	1	40.46%
2. *Spirodela polyrrhiza*	giant duckweed	3	5.93%
3. *Secale cereale*	rye	0	5.21%
4. *Lemna minor*	common duckweed	2	4.85%
5. *Lythrum salicaria*	purple loosestrife	0	4.84%

Table 1: Top Five species of data from both pre- and post-restoration. Red coloration of C-values indicate non-native species that remain unchanged by human disturbance and green coloration represents species that are exclusive to relatively unchanged, undegraded habitats. Images shown in Figures 6a & 6b.

<u>Discussion</u>

The increase in w$\bar{C}$ and species richness post restoration indicate early success for the restoration methods implemented. The removal of cattail, one round of plantings done post-restoration on the mounds, and seeds from the seedbank may be responsible for the significant increase in species richness. Low water levels and an insufficient amount of time for plant establishment may indicate the lack of significance in w$\bar{C}$ between control plots and restoration sites in 2021.

(Continued on p. 5)

Figure 6a. Top five species from pre-restoration transects, 2019. From left to right: Typha x glauca, Thelypteris palustris, Decodon verticillatus, Boehmeria cylindrica, and Persicaria amphibia

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(Continued from p. 4)

There will be future plantings of *Calamagrostis canadensis* and *Carex lacustris* to further improve biodiversity on the bench and mounds of the channels. Species with high C-values, like *Thelypteris palustris* and *Decodon verticillatus*, are more sensitive to human disturbance and we will expect to see them increase as time progresses. Whereas Species with lower c-values like *Secale cereale* are more tolerant of disturbance and serve to stabilize the soil for future communities. One limitation of the data stems from the ability of the field botanists to accurately identify taxa.

Figure 6b. Top five species from post-restoration transects, 2021. From left to right: Typha x glauca, Spirodela polyrrhiza, Secale cereale, Lemna minor, Lythrum salicaria

References

[1] D. Larkin, M. Freyman, S. Lishawa, P. Geddes, N. Tuchman, “Mechanisms of dominance by the invasive hybrid cattail Typha × glauca” in *Biological Invasions*, vol. 14, pp. 65–77, January, 2012.

[2] T. E. Kutcher, G. E. Forrester, “Evaluating how variants of floristic quality assessment indicate wetland condition” in *Journal of Environmental Management*, vol. 217, pp. 231–239, July 2018.

[3] D. A. DeBerry, S.J. Chamberlain, J. W. Matthews, “Trends in floristic quality assessment for wetland evaluation” in *Wetland Science & Practice*, vol. 32, pp. 12-22, July 2015.

[4] M. Chung-Gibson, “The Wisconsin Floristic Quality Assessment Calculator” in *Wisconsin Department of Natural Resources*, [online]. Available: https://dnr.wi.gov/topic/Wetlands/methods.html

[5] G. Spyreas, “Floristic Quality Assessment: a critique, a defense, and a primer” in *Ecosphere*, vol. 10, no. 8, e02825, August 2019.

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Featured Astrophotography: The Ghost of Cassiopeia

By James and Judy Canning, ASRAS members

A white nebulae illuminated by the nearby star, *Gamma Cassiopeia*, 34,000 times brighter than our sun. The nebula is lit brilliant colors where the nebula glows from the star's radiation.

November in Letchworth State Park

Photos taken by Theodore W. Lechman, RAS Bulletin Editor, on November 9, 2021 at approximately 3:00 p.m.

Figure 1: North exit of Great Bend Overlook, Park road.

Figure 2: High Falls

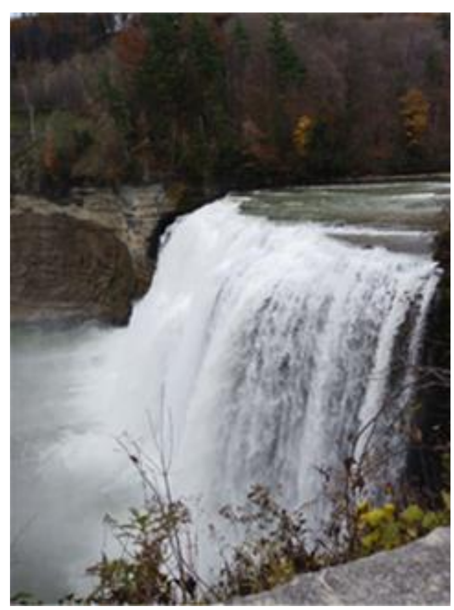


Figure 3: Middle Falls

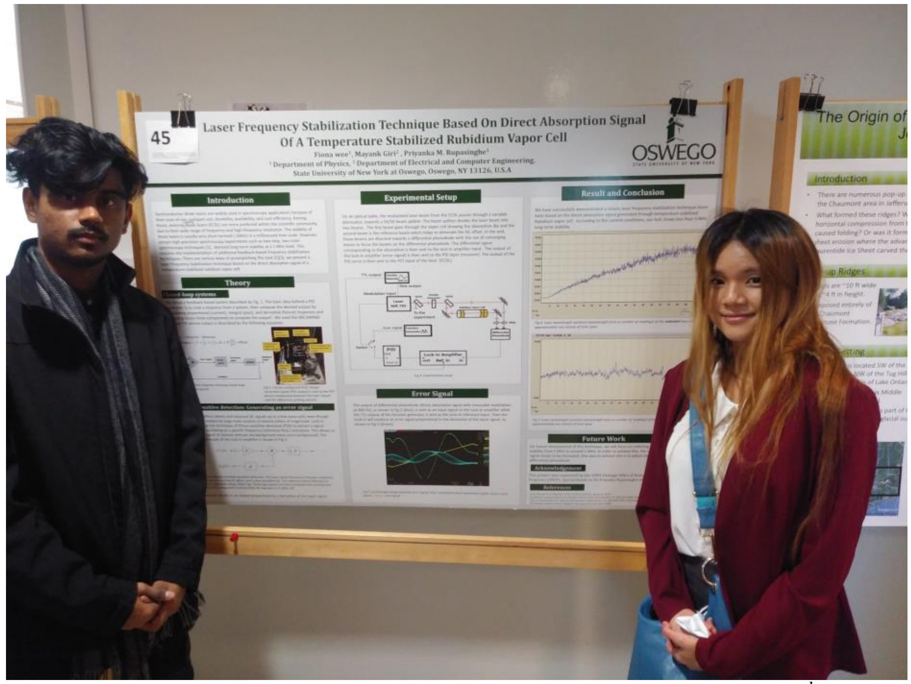
Featured 2021 RAS Paper Session Poster

Fiona Wee, Mayank Giri,
Priyanka M. Rupasinghe, Ph.D.,
SUNY Oswego.

Laser Frequency Stabilization Technique Based on Direct Absorption Signal of a Temperature Stabilized Rubidium Vapor Cell

Abstract

Semiconductor diode lasers are widely used in spectroscopy applications because of their ease of use, compact size, durability, availability, and cost-efficiency. Among those, external-cavity diode lasers (ECDL) are more preferred within the scientific community due to their wide range of frequency and high-frequency resolution. The stability of these lasers is usually very short-termed (1MHz) in a millisecond time scale. However, certain high-precision spectroscopy experiments such as two-step, two-color spectroscopy techniques [1], demand long-term stability at a 1 MHz level. This requires the implementation of additional feedback-based frequency stabilization techniques. There are various ways of accomplishing this task [2][3]. Here we present a laser frequency stabilization technique based on the direct absorption signal of a temperature-stabilized rubidium vapor cell.



Authors Fiona Wee and Mayank Giri in front of their poster at the 47th Annual RAS Fall Paper Session held November 6th at Nazareth College.

Closed-loop systems

We setup a feedback based system described by figure 1. The basic idea behind a PID controller is to read a response from a system, then compute the desired output by calculating proportional (current), integral (past), and derivative (future) responses and summing those three components to compute the output[2]. We used the SRS SIM960 Analog PID whose output is described by the following equation.

$$\varepsilon = \text{Setpoint} - \text{Measure}$$

$$\text{Output} = P \times \left\{\varepsilon + I\int \varepsilon\, dt + D\frac{d\varepsilon}{dt}\right\} + \text{Offset}$$

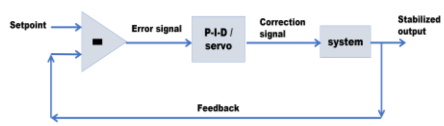


Figure 1: Block diagram showing closed loop feedback system

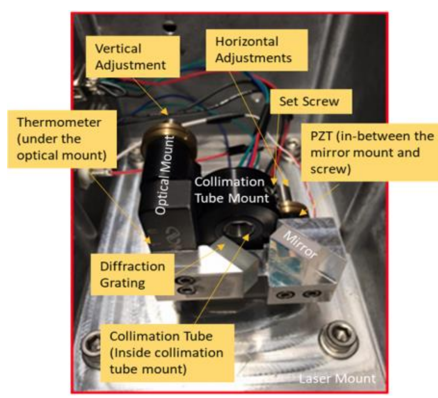


Figure 2: Littrow configured ECDL design. Correction signal (PID output) is sent to the PZT device sandwiched between the laser mount and the diffraction grating mount).

Phase sensitive detection: Generating an error signal

Lock-in amplifiers detect and measure AC signals up to a few nanovolts even though tiny signal is hidden by large noise sources of several orders of magnitude. Lock-in amplifiers use the technique of Phase-sensitive detection (PSD) to extract a signal component oscillating at a specific frequency (reference freq.) and phase. This allows us to detect a signal of interest without any background noise (zero-background). The operating principle of the lock-in amplifier is shown in figure 3. This process results in an output proportional to a derivative of the input signal

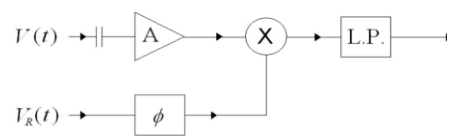


Figure 3: Block diagram of phase-sensitive detection. The input signal V(t) passes through a capacitor, blocking any pre-existing DC offset, and is then amplified (A). The reference signal $V_R(t)$ passes through an adjustable phase shifter (φ). These two signals are then multiplied and resulting low-frequency (DC) component is extracted by the low-pass (L.P.) filter. [4]

Experimental Setup

On an optical table (figure 4), the modulated laser beam from the ECDL passes through a variable attenuator, towards a 50/50 beam splitter. The beam splitter divides the laser beam into two beams. The first beam goes through the vapor cell showing the absorption dip and the second beam is the reference beam

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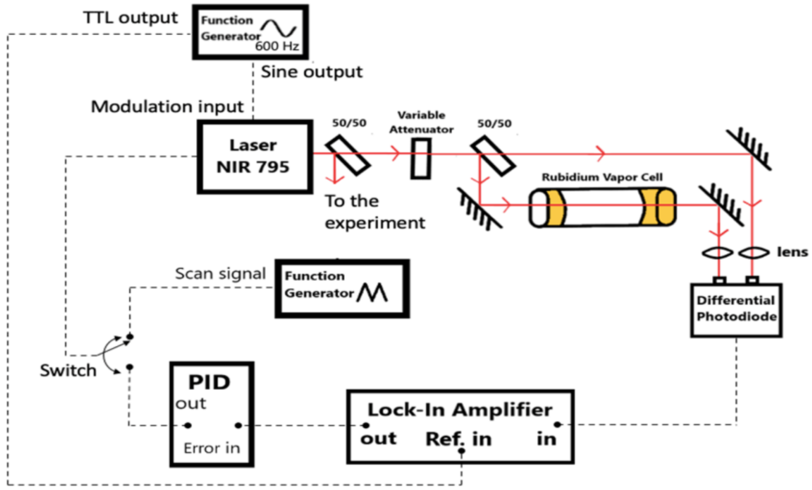

Figure 4: Experimental setup

which helps to eliminate the DC offset. In the end, these beams are directed towards a differential photodiode with the use of converging lenses to focus the beams on the differential photodiode. The differential signal corresponding to the absorption is then sent to the lock-in amplifier input. The output of the lock-in amplifier (error signal) is then sent to the PID input (measure). The output of the PID servo is then sent to the PZT input of the laser (ECDL).

Error Signal

The output of differential photodiode (direct absorption signal with sinusoidal modulation at 600 Hz), as shown in figure 5 (*blue*), is sent as an input signal to the Lock-in amplifier while the TTL output of the function generator is sent as the Lock-in reference input. Then the Lock-in will produce an error signal proportional to the derivative of the input signal. As shown in figure 5 (*Green*).

Figure 5: oscilloscope image showing error signal. ***Blue:*** *modulated direct absorption signal.* ***Green:*** *error signal.* ***Yellow:*** *scan signal.*

Result and Conclusion

We have successfully demonstrated a simple laser frequency stabilization technique (laser lock) based on the direct absorption signal generated through temperature stabilized Rubidium vapor cell. According to the current conditions, our lock shows less than 5 MHz long-term stability.

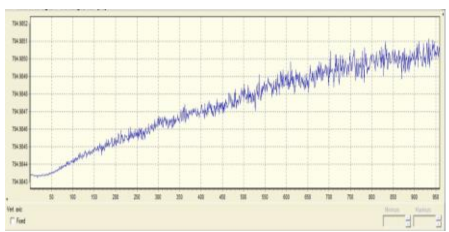

Figure 6: Laser wavelength variation (wavelength (nm) vs number of readings) of the ***unlocked*** *laser over approximately one minute of time span*

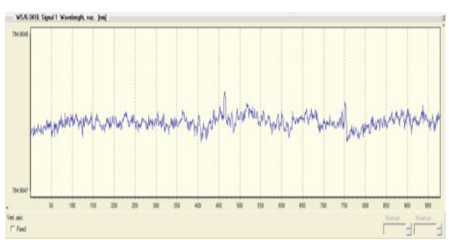

Figure 7: Laser wavelength variation (wavelength (nm) vs number of readings) of the ***locked*** *laser over approximately one minute of time span.*

Future Work

For future development of this technique, we will focus on reducing the level of long-term stability from 5 MHz to around 1 MHz. In order to achieve this, the steepness of the error signal needs to be increased. One way to achieve this is to adjust (increase) the gain of the differential photodiode. Also, as the next phase of development, the use of a doppler-free (narrow) saturated absorption signal may help to achieve long-term stability below the 1 MHz level.

Acknowledgement

This project was supported by the Challenge Grant (SUNY-Oswego). Special thanks to Dr. Priyanka Rupasinghe who supervised this research.

References

[1] G. Ranjit, D. Kealhofer, G. D. Vukasin, P. K. Majumder, “Measurement of $7p_{1/2}$-state hyperfine structure and $7s_{1/2}$-$7p_{1/2}$ transition isotope shift in ^{203}Tl and ^{205}Tl” in *Physical Review A*, vol. 89, p. 012511, January 2014.

[2] M Gunawardena, P. Hess, J. Strait, P. Majumder, “A frequency stabilization technique for diode lasers based on frequency-shifted beams from an acousto-optic modulator” in *Review of Scientific Instruments*, vol. 79, p.103110, October 2008.

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Featured Astrophotography: Crescent Nebula Wide Field Image

By Bill Schlein, ASRAS member

Images show the area around Sadr (*Gamma Cygni*) including the Crescent Nebula (NGC 6888) and open cluster M29 among others. Images taken on November 7, 2021 from Bill Schlein’s driveway at the edge of the Spencerport.

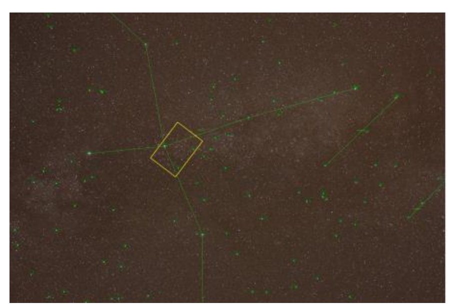

Figure 1: Here is an annotated single image taken with a DSLR and 35mm lens to provide the context.

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Bill Schlein Astrophotography
(Continued from p. 7)

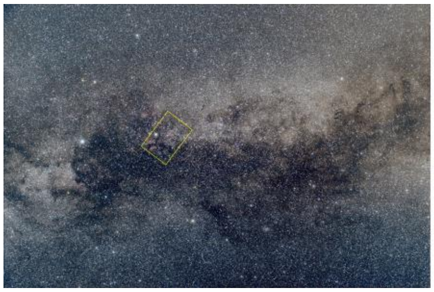

Figure 2: Combined stack from the same DSLR and lens to show how rich this area of the sky is.

Figure 3: finally, the image from the other night.

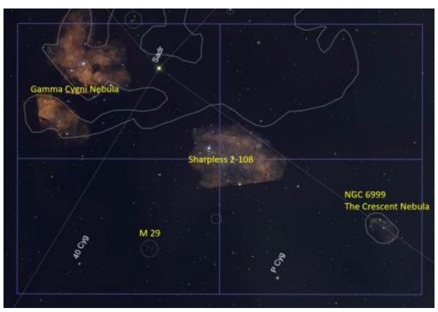

Figure 4: Annotated view of figure 3 above.

ROCHESTER RESEARCH IN REVIEW

November 18, 2021, University at Buffalo, Live long and prosper: Study examines genetic gems in Galápagos giant tortoise genomes

November 18, 2021, Cornell, New cell database paints fuller picture of muscle repair

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November 16, 2021, Cornell, Artificial intelligence successfully predicts protein interactions

November 13, 2021, URMC, Anxiety cues found in the brain despite safe environment

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November 12, 2021, University of Rochester, More evidence of an evolutionary 'arms race' between genes and selfish genetic elements

November 11, 2021, URMC, New study finds evidence of COVID antibodies in breast milk of vaccinated mothers

November 9, 2021, Cornell, That new EV battery will be a headache to recycle: These solutions can help

November 9, 2021, Cornell, Can't find your keys? You need a chickadee brain

November 5, 2021, URMC, Multiple sclerosis drug improves memory in mice modeling Alzheimer's disease

November 4, 2021, Cornell, When is a basin of attraction like an octopus?

November 3, 2021, University at Buffalo, Let's talk about the 1,800-plus 'young' volcanoes in the US Southwest

November 2, 2021, University of Rochester, Better models of atmospheric 'detergent' can help predict climate change

November 2, 2021, Binghamton University, People prefer friendliness, trustworthiness in teammates over skill competency

November 1, 2021, Syracuse University, Uncovering the secrets behind Earth's first major mass extinction

October 29, 2021, University of Rochester, Researchers set 'ultra-broadband' record with entangled photons

October 25, 2021, A big leap forward in using iron catalysts for pharmaceuticals

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