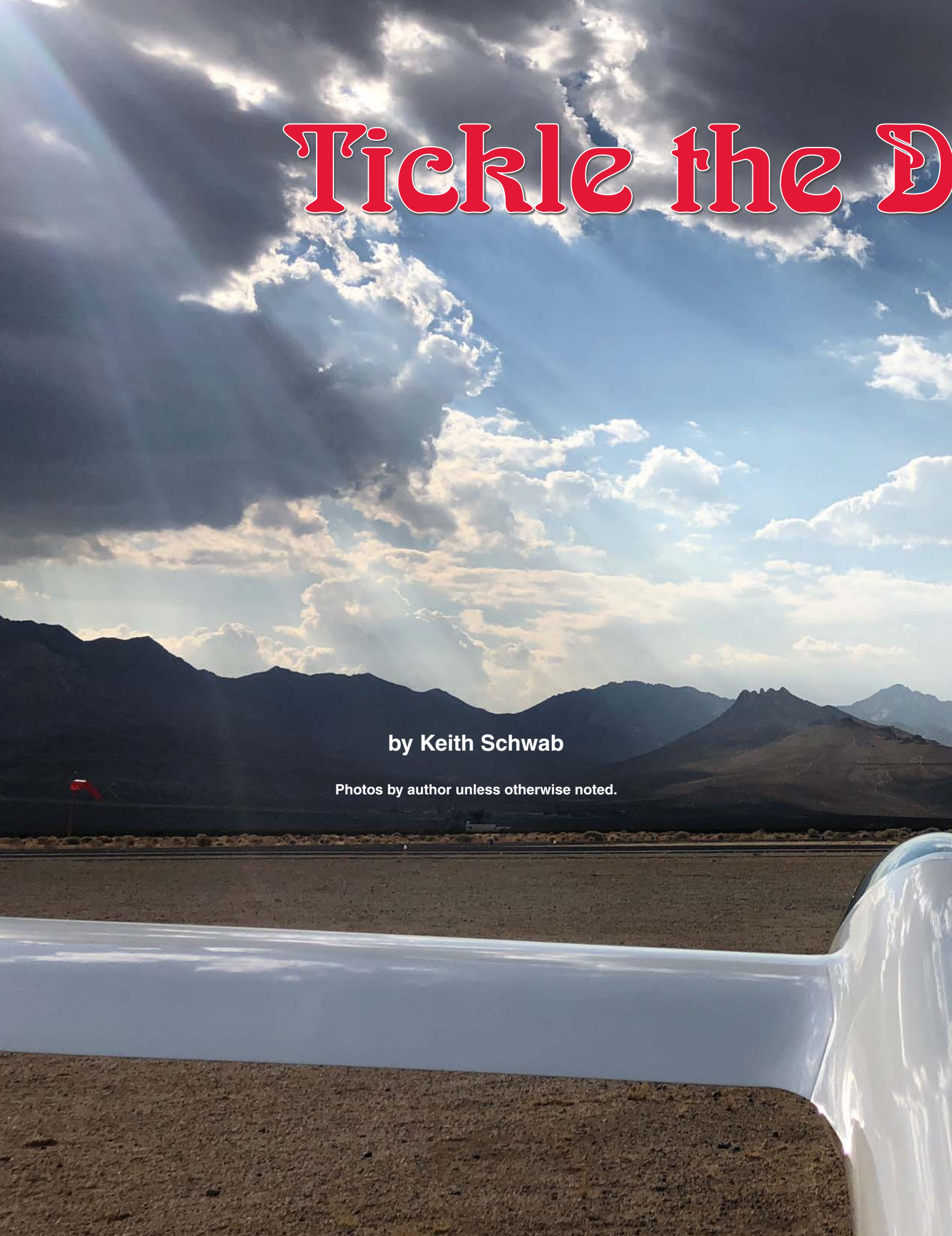
Tickle the D



by Keith Schwab

Photos by author unless otherwise noted.

ragon's Tail

During the climb.

N303DG at Inyokern, CA (KIYK).

When I first discovered soaring in 2014, some basic questions came to mind. How far can you fly? How long can you stay up? *How high can you fly?* When I asked these questions, my instructor told me about world altitude records flown by Paul Bikle, who achieved 46,267 ft in 1961, and Robert Harris, who achieved 49,009 ft in 1986, not far from where we were flying. I simply could not believe this was possible. After further investigation, I discovered Paul McCready's wave flights in Bishop, CA, in the late 1940's, and the Sierra Mountain Wave Project during the 1950's with flights to over 40,000 ft with surplus World War II Pratt-Read TG-32 gliders. I also read about gliders shattered in flight by violent rotor turbulence, and fatal accidents caused by hypoxia.

N303DG in flight over the Sierra Nevada.

Glider flight at these altitudes is extremely interesting, but also something to be approached with real caution, sober thought, and careful preparation. When one attempts to fly far, one can always keep a safe landing site within glide. When one flies high, there is no equivalent to a landout if something goes wrong. It is truly an unforgiving environment, and when attempted in a single place ship, you are on your own.

The snowy Sierra.

I am a 53-year-old professor of physics at Caltech and I love exploring the limits of both the natural world and myself. I came to soaring relatively late in life. On my first flight at the Southern California Soaring Academy (46CN), we released at 4,000 ft AGL, contacted a gentle lee wave, and floated up to 14,000 ft. This was pure magic, and I was hooked; frightened but hooked. I got over the fear, and about two years after my training, purchased a 1996 Glaser-Dirks DG-303. I keep this ship at KIYK (Inyokern, CA), which is at the south end of the Sierra Nevada. The Sierra forms the east side of Owens Valley, the deepest valley in the lower 48 states, and create an epic soaring playground.

Britton Bluedorn and the author after landing, December 17, 2020. Photo by Britton Bluedorn.

Over the past four years I have had the chance to fly in the lee wave of the Sierra Nevada and found it to be just as described in Robert Whelan's book *Exploring the Monster:* exciting, powerful, and sometimes terrifying. On one wave flight, I encountered rotor turbulence near Mt. Whitney which was pure violence, first smashing me down and down, then rocketing me up and up at a rate of over 3,000 fpm, all at 24,000 ft. I was tossed around, struggling to maintain proper attitude, and was scared about how high the lift would take me; I retreated downwind to get out of the lift and regroup. A bit sporty, as the old guys say. I was

alive, the glider was fine, the monster was most definitely up there, and after some careful consideration, I committed myself to the only reasonable next step: to put together the system to take me much higher and explore further.

Preparation

Oxygen. The essential piece of gear required to support life above 28,000 ft is a diluter-demand pressure breathing regulator. I use an A-14 regulator with a modern pressure breathing mask (MBU-20/P). This mask must seal tightly to the face since the regulator will apply increasingly larger positive pressures as the altitude increases above 35,000 ft. *[Men, make sure to shave your face before using — Editor.]* The pressure both overcomes any leaks in the mask, and fully opens the alveoli in the lungs. This system can keep blood oxygenated at over 90% up to 42,000 ft, and over 80% up to 45,500 ft. At 49,000 ft, the A-14 can maintain only 70% blood oxygenation, which shows that Harris' record is very near the upper limit for an unpressurized ship. If the A-14 fails, I have a fixed flow system which can activated with a valve turn. If this also fails, I can switch to a separate 2 cu-ft bailout bottle. Above 35,000 ft, turning those valves must happen within 30-60 seconds of the oxygen failing; above 40,000 ft this must happen within 10-20 seconds.

Airspace. We can fly to high altitude in the military operations area (MOA) controlled by Edwards Air Force Base (R2508 complex). I have a letter of agreement with Edwards which grants permission to fly in the class-A space above 18,000 ft. The gist of the letter is: *We, the U.S. Government, fly supersonic, shoot missiles, drop bombs, blow up many things, etc., in this airspace. If you are killed while flying in R2508, it's your own danged fault.* I am paraphrasing, but the point is clear: fly here at your own risk. I have been passed flying at 20,000 ft, closer than I would have liked, by a B-1 bomber chasing an air tanker. There is no confusion: this is definitely their airspace.

Weather. To forecast the wave, I use Skysight. I look for days with wind speeds at mountain level of 50 mph and windspeed at the top of the troposphere, at 40,000 ft, of 100 mph. There are days when winds at high altitude can reach over 200 mph, when the jet stream is passing directly over the Sierra. Those are to be avoided. During the Sierra Wave Project, Larry Edgar

Above: Author after the flight. Photo by Britton Bluedorn. Left: Oxygen circuit showing 22cu-ft bottle, A-14 regulator, MBU-20/p mask, fixed flow system, and bailout bottle. Below: A-14 diluter-demand pressure breathing regulator (Fluid Power, Inc.).

encountered rotor turbulence so violent and explosive that he found himself suddenly outside the glider, falling with fragments of the ship, and blinded by sudden g-forces estimated to be more than 16 g. He lived, and we learn from his experience; on those days, I stay home.

The Flight to 36,630 ft, December 17, 2020

We launched around 9:30 am from Inyokern with Jeff Montgomery flying the Sierra Soaring Club's 1958 Cessna 182, and surface winds of 20 kt. Inyokern is approximately ten miles from the mountain ridge, at 2,500 ft MSL. Flying through rotor always gets one's attention. At Minden, NV, instructions to pilots being towed through the rotor are: disconnect if you are inverted or in front of the tow plane (!); otherwise, stay on tow and fight! This tow was very dynamic, and it was sometimes difficult to stay in formation, but it wasn't terrible. Together, we contacted the wave at about 7,500 ft and I stayed connected with the tow plane in smooth lift for another 500 ft, to be certain I was in the laminar wave. Rotor clouds were downwind of my location, with no lenticular clouds visible. I found moderate lift of 500 fpm, and began to settle in for the climb. My goal for the day was above 35,000 ft to earn a Symons Wave Memorial Award Double-Lennie pin (totally worth it).

Everything was going great until at about 30,000 ft. I went to adjust the elevator trim: it was totally frozen and would not budge. I then noticed that the stick had become very stiff. In that moment, I was concerned I might soon lose control of the glider, and mentally went over the steps to bail out. However, when I applied pressure to the stick, the glider responded, in both the bank and pitch axes. The motion of the stick was small, but I was still in control. For the next few minutes, I wrestled with the question: descend now while I still had control and get to a lower altitude where the stick was totally free, or keep going up, risking that the stick might freeze completely. The temperature at 30,000 ft was about -55°F and forecast to be -70° at 35,000 ft. I could see the spoiler covers were warped, and I suspected the stick was binding due to the relative thermal contraction between the metal controls and the composite ship. Another 15° should

N303DG at Inyokern, CA (KIYK).

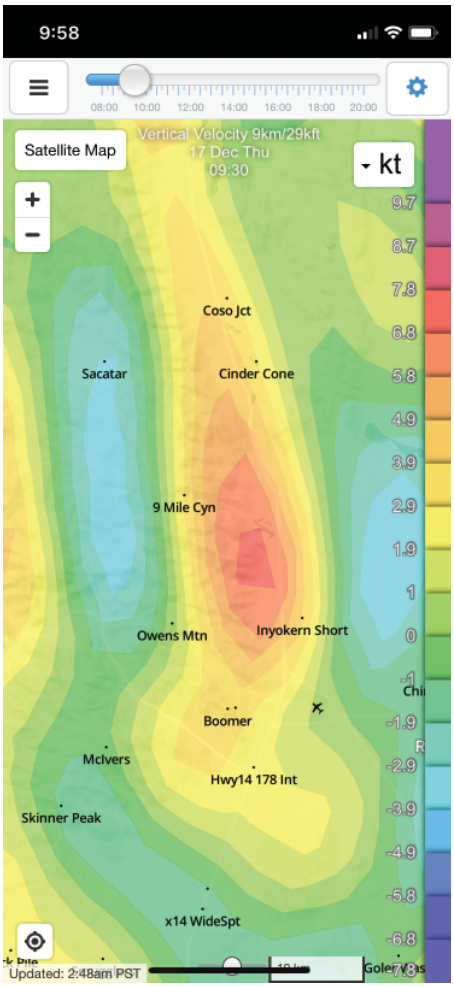
not cause too much more contraction, right? I had already gone from 60° to -55°, a change of 115°; could another 15° be OK?

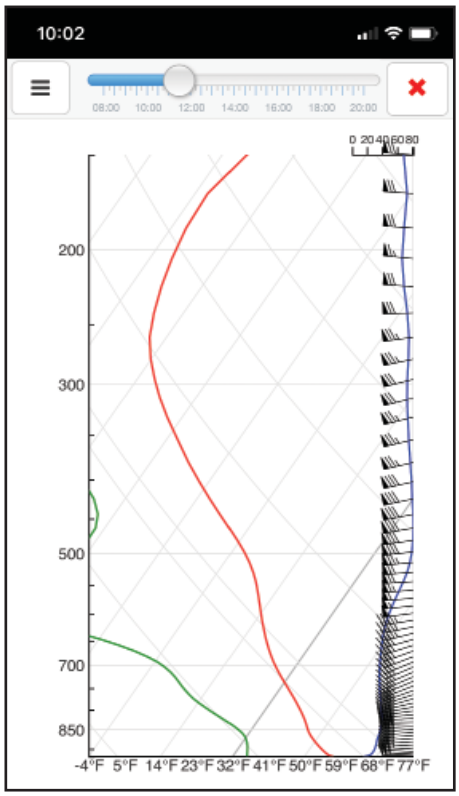
I decided to keep going up. In retrospect, that was clearly not the most conservative decision. (What aspect of this flight was conservative?) As I climbed, the lift tapered off and my altitude seemed to be stagnating at 34,500 ft, 500 ft below the Double-Lennie. I pushed upwind and fortunately found more lift, going up at 500 fpm. I climbed another 2,000 ft and confirmed all my flight computers showed an altitude of above 36,000 ft. Done. Now, to get down ASAP.

My next concern was the spoilers: would they be frozen shut and inoperable? How long would it take to get down? The spoilers opened with some real effort, and relief, on my part. I pushed the nose down and flew near VNE, descending from 36,630 ft to 15,000 ft in about 13 minutes. I watched two F-15's chasing an air tanker below me. The increased airspeed made the cockpit extremely cold, and I loitered at 15,000 ft to warm up and consider the landing.

When I got on the ground, I was extremely happy to be down safe and was greeted by my fellow wave pilot, Britton Bluedorn, with a big "well done!" It only took a week before I began dreaming of a flight above 40,000 ft. When I left the lift at 36,000 ft, the air was still going up at 500 fpm; it is clear that flights above 40,000 ft are possible at Inyokern. After some thought and discussion with other pilots, I decided to search for an SGS 1-34 and configure it as a wave ship. The 1-34 is all metal, easy to lubricate for low temperatures, mechanically robust, roomy, inexpensive, and has a large useful load. Stewart Ayotte and I recently purchased N7595 for this purpose, and have begun preparations.

Richard Feynman coined the phrase "tickle the dragon's tail" to describe the dangerous process of carefully assembling configurations of fissile material in the laboratory, just barely below the critical threshold for a runaway nuclear chain reaction. There is no doubt that when flying the Sierra wave, one is tickling some sort of fascinating dragon.

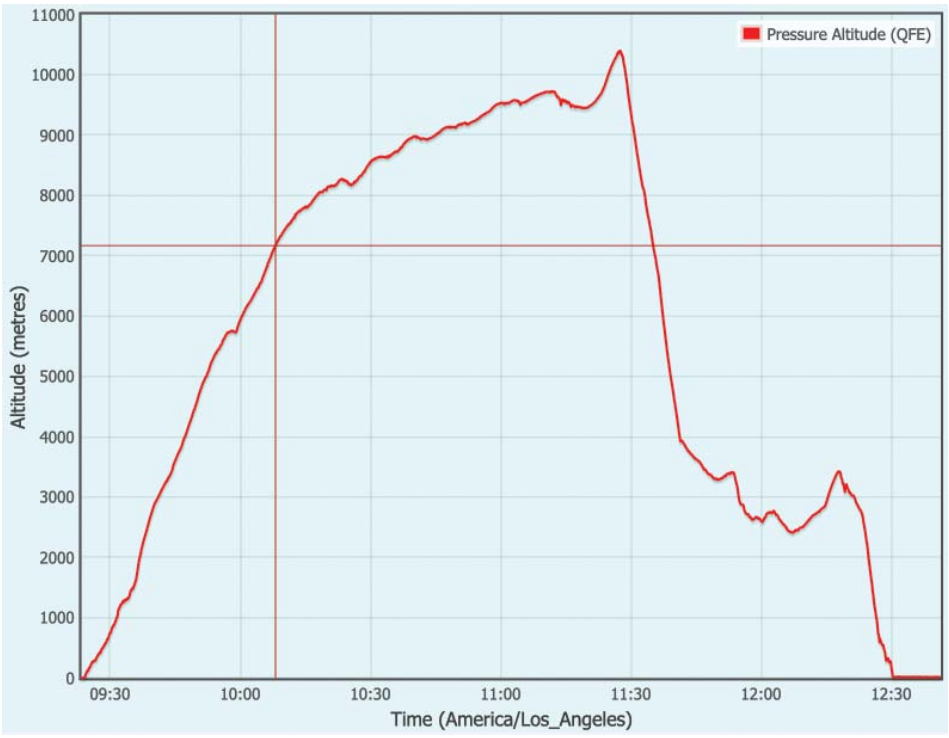




Left: Skysight forecast of wave at 29,000 ft.

Right: Skysight forecast of skewT at KIYK showing wind aloft peaking at 90kts, oriented perpendicular to the mountain ridge, and the troposphere/tropopause transition at around 40,000 ft.

Below: Altitude trace of the flight.



Left: Stacked lenticular over a helical rotor cloud marking the mountain lee wave in the Owens Valley near Bishop, CA.

Below: The author.

Acknowledgements: Thanks to Britton Bluedorn, Jim Payne, Walt Rogers, Tom Serkowski, BJ Holden, Stewart Ayotte, Marty Eiler, and Dale Masters. For more technical information, please see: kschwabresearch.com/wave-notes.

[While high-altitude flights can amaze, they should only be made with the most careful preparation, correct equipment, and a clear-eyed understanding of the many risks involved. This article was originally published in May 2021 Aerokurier *magazine. — Editor]*

About the author: *Keith is a professor of applied physics at Caltech and researches the quantum properties and applications of superfluid helium (did you know a perfect fluid with zero viscosity flowing over a wing generates zero lift?) He enjoys backpacking, landscape photography, and soaring in the mountains.*