

# RESEARCH IN HIGH

## MICROGRAVITY EXPERIMENTS ADVANCE MATERIALS SCIENCE

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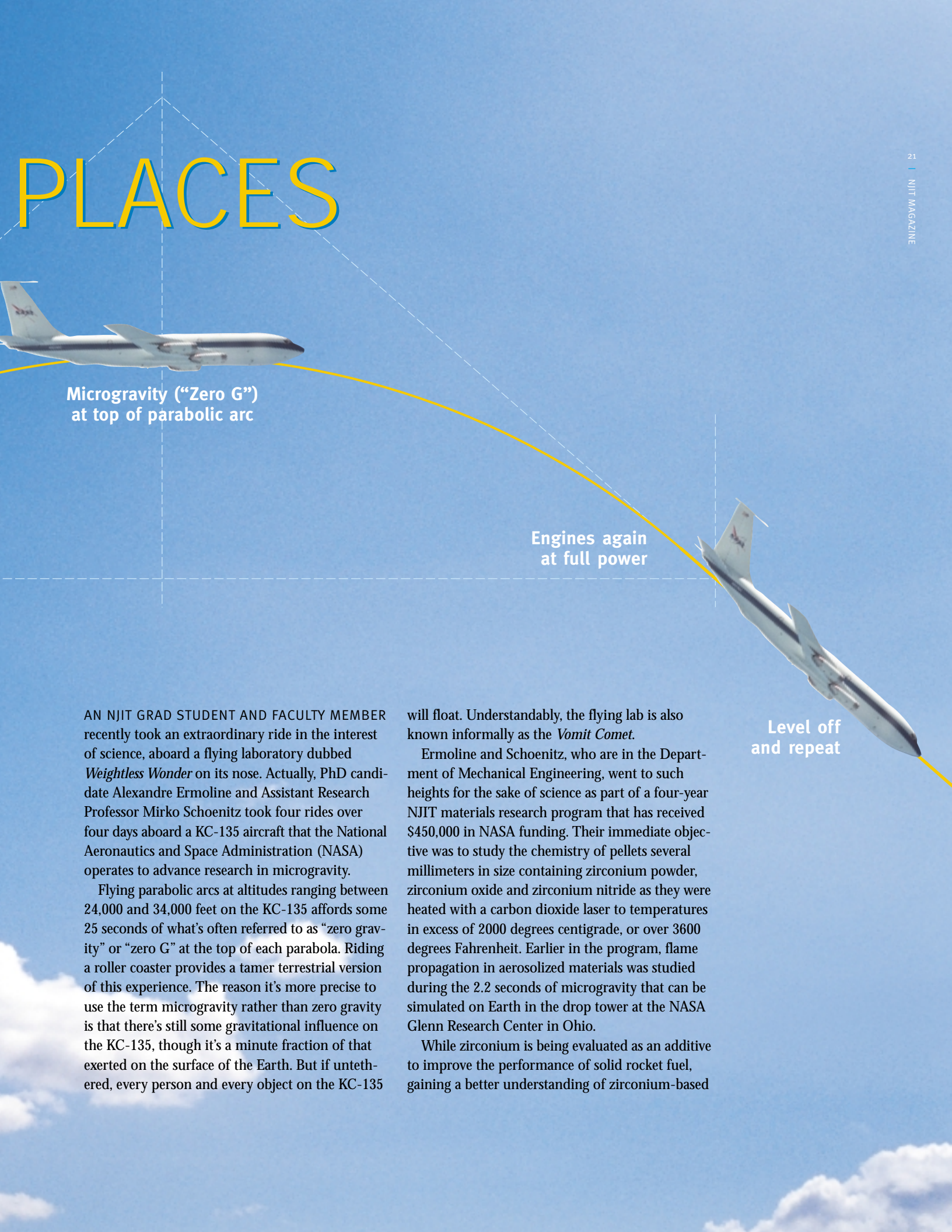
Throttle back

Steep climb  
at full power

The aeronautical lineage of the Boeing KC-135 used for NASA's microgravity program includes the basic design for the famous 707 airliner, one of the first jet aircraft to provide commercial passenger service. The NASA program was launched in 1959 as a way to study the reactions of humans and hardware in weightlessness. Since then, many thousands of parabolas have been flown in support of space exploration and basic research, including experiments initiated by NJIT in materials science and microfluidics. Scenes in weightlessness for the movie *Apollo 13* were also filmed aboard the KC-135.



# PLACES



Microgravity ("Zero G")  
at top of parabolic arc

Engines again  
at full power

Level off  
and repeat

AN NJIT GRAD STUDENT AND FACULTY MEMBER recently took an extraordinary ride in the interest of science, aboard a flying laboratory dubbed *Weightless Wonder* on its nose. Actually, PhD candidate Alexandre Ermoline and Assistant Research Professor Mirko Schoenitz took four rides over four days aboard a KC-135 aircraft that the National Aeronautics and Space Administration (NASA) operates to advance research in microgravity.

Flying parabolic arcs at altitudes ranging between 24,000 and 34,000 feet on the KC-135 affords some 25 seconds of what's often referred to as "zero gravity" or "zero G" at the top of each parabola. Riding a roller coaster provides a tamer terrestrial version of this experience. The reason it's more precise to use the term microgravity rather than zero gravity is that there's still some gravitational influence on the KC-135, though it's a minute fraction of that exerted on the surface of the Earth. But if untethered, every person and every object on the KC-135

will float. Understandably, the flying lab is also known informally as the *Vomit Comet*.

Ermoline and Schoenitz, who are in the Department of Mechanical Engineering, went to such heights for the sake of science as part of a four-year NJIT materials research program that has received \$450,000 in NASA funding. Their immediate objective was to study the chemistry of pellets several millimeters in size containing zirconium powder, zirconium oxide and zirconium nitride as they were heated with a carbon dioxide laser to temperatures in excess of 2000 degrees centigrade, or over 3600 degrees Fahrenheit. Earlier in the program, flame propagation in aerosolized materials was studied during the 2.2 seconds of microgravity that can be simulated on Earth in the drop tower at the NASA Glenn Research Center in Ohio.

While zirconium is being evaluated as an additive to improve the performance of solid rocket fuel, gaining a better understanding of zirconium-based





Alexandre Ermoline (at top) and Mirko Schoenitz weightless on one of their four KC-135 flights

The experiments on the KC-135 were very successful, yielding new data about materials essential to technological advances on Earth and in space.

materials heated to very high temperatures is valuable for many other applications, including the development of gas sensors, fuel cells and ultra-hard coatings. Associate Professor Edward Dreizin, principal investigator for the NJIT program, explains that the key advantage of performing this research in a weightless environment is that the free-floating pellets can be precisely positioned and laser-heated without touching any other material. It is impossible to conduct these studies in normal gravity at high temperatures because the

materials under investigation will react with any container and compromise the data generated.

The two researchers from NJIT, as well as their equipment, had to undergo extensive preflight preparation. At NASA's Lyndon B. Johnson Space Center in Houston, Texas, Ermoline and Schoenitz went through training that included being subjected to conditions in a pressure chamber simulating a decompression emergency on the KC-135. Before the actual flights, which took off from Ellington Field near Houston, they were also given medication to minimize motion sickness. Airborne, in addition to weightlessness, the researchers experienced twice the pull of the Earth's gravity as the KC-135 accelerated to altitude. But it was all fun, Ermoline says with a touch of wry humor.

NASA's requirements for getting the NJIT experimental setup into the air were, if anything, even more stringent. For example, Schoenitz says that all such equipment taken aboard the KC-135 has to be able to withstand ten times the force of terrestrial gravity, or 10 G's, in every axis for reasons of safety. However, NJIT had to convince the space agency that the university's equipment was exceptionally robust, he adds. That's because it had to contain a high-temperature experiment that involved operating a 125 Watt Class IV laser — the most powerful laser ever flown on the KC-135.

Dreizin says that Vern Hoffmann, an NJIT research engineer, and other members of his micro-gravity project team spent three years getting their apparatus ready for lab tests at the university. It took another full year of special preparation to ready the equipment for the KC-135 experiments and to pass NASA's rigorous safety review. While everyone was apprehensive as the time approached to take to the air, all turned out well. The experiments on the KC-135 were very successful, yielding new data about materials essential to technological advances on Earth and in space.

Ermoline, Schoenitz, Hoffmann and Dreizin are now preparing the results for publication. With these experiments, their current NASA-funded microgravity research nears its conclusion. However,





(Above) Ermoline and Schoenitz riding to the altitude for their microgravity research — with motion-sickness bags at the ready



(Left) Preparing NJIT's high-temperature microgravity experiment for flight with the assistance of NASA personnel

they're thinking about new proposals, among them more work on the microgravity materials frontier. The continuing NASA program in this area, which still has a number of university and industry projects under way, also offers the possibility of experimentation on the Space Shuttle and the International Space Station. Perhaps at some point in the future, NJIT researchers will take their search for new knowledge to even greater heights. ■

**NJIT's Department of Mechanical Engineering on the Web: [www.njit.edu/ME](http://www.njit.edu/ME)**