

# Space Exploration

## Spacecraft of the Future

Suzanne Weaver Smith's current research is really out there. Out in space, deep space.

Among her projects to develop novel computer modeling and laboratory testing methods for spacecraft, Smith, an associate professor of mechanical engineering, is focusing on "gossamer materials"—strong, very thin, ultra-lightweight, and highly flexible materials that can be tightly compacted for launch and then deployed once in space.

Large expanses of reflective gossamer material could provide the propulsion of futuristic solar sail spacecraft into deep space. Or, nearer to Earth, this material might be utilized in support structures for next-generation space telescope mirrors, for deployable satellite solar energy collectors or for sun shields.

With the help of supercomputers, Smith has worked to predict the gossamer material's motion response to dynamic disturbances such as those commonly found in space. Predicting the motion of the gossamer spacecraft requires computing the motion at thousands of finite points within it, a computational process involving millions of equations. With a better understanding of how these gossamer spacecraft respond to disturbance, Smith and her team could then redesign the material, including implementing intricate patterns within it, much like crimping hair, to amplify its strength and stability.

"Ultimately, if you can compute the solutions and predict the motion response, you can help design stronger materials and better spacecraft," Smith says. "We can test for degradation and performance under various conditions, and then change the design to produce the response we require."



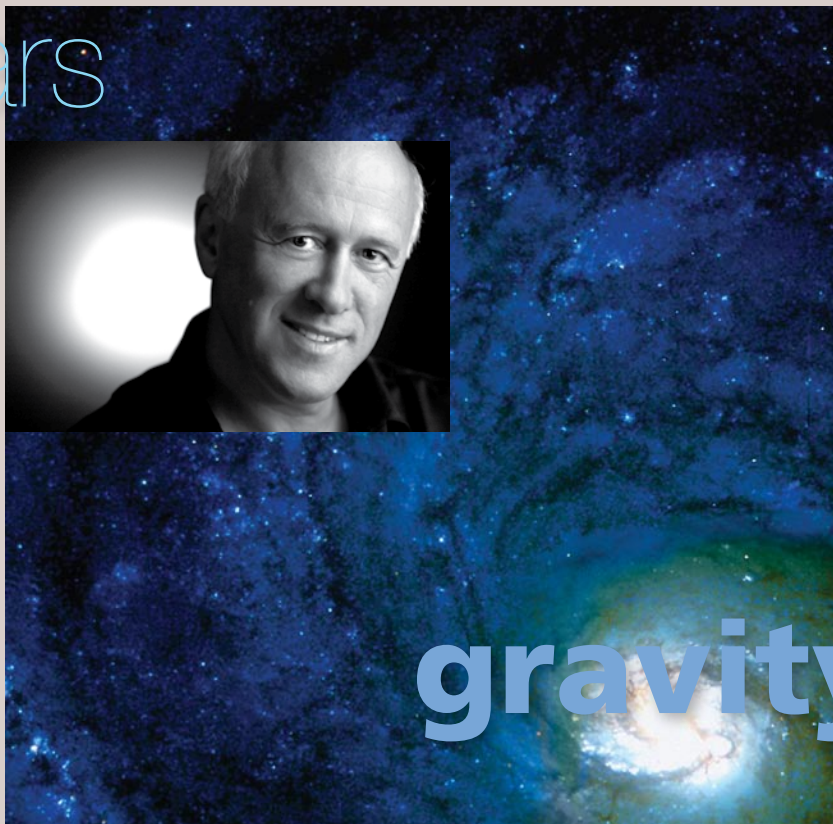
# quasars

## Configuring the Birth of the First Stars

Gary Ferland, a professor of physics and astronomy, is also a genealogist of sorts. His ongoing project involves tracing the birth of the very first stars in the universe.

To accomplish this formidable task, he studies quasars—small, intense celestial sources of radiation characterized by large changes in wavelength—and his “partner” in this research is the Hubble Space Telescope, our eye on the universe that can see billions of light years away. “The Hubble ‘observes’ quasars through spectroscopy, a way of separating electromagnetic radiation according to wavelengths,” explains Ferland, who analyzes data downlinked from the space telescope.

In his work, he uses an advanced computer program that simulates astronomical objects like quasars and supernovae. He admits the fundamental challenge of such a project is numerically simulating what goes on in a quasar. “In astronomy we can’t do an experiment as you can in physics. All we can do is observe what comes to us,” he says. “There’s an old saying in the field: ‘Those who can do, do; those who can’t, simulate.’”



## Building Galaxies from Scratch

Isaac Shlosman keeps his own personal galaxies in the basement. Below ground, in the UK Chemistry-Physics building, his galaxies pulse on a cluster of computers. Created by software written by Shlosman and his team, this 3-D, animated model may one day help scientists grasp the formation and evolution of galaxies.

“Galaxies are the building blocks of this universe, and inside each galaxy there is the part we can see—ordinary luminous matter like stars—and the part we can’t see, so-called dark matter,” explains Shlosman, a professor in the physics and astronomy department.

Scientists measure dark matter by the gravity it produces. “After the Big Bang, the universe was perfectly uniform and homogenous—like an even spread of butter on toast,” he says, “but gravity stepped in. Because

the universe is relatively young, less than 14 billion years old, gravity was only partially successful in clumping the matter. Ordinary luminous matter falls into traps prepared by dark matter, so it clumps together with the dark matter.”

He explains that this clumping forms two types of galaxies: disks (circles with spiral arms) and ellipsoids (3-D ovals). How the universe decides which kind to form is the question he and his team are trying to answer with his computer models by letting gravity operate virtually to clump the matter.

These simulations are rooted in reality: the latest observations from world-class telescopes across the globe. These glimpses into space, combined with analysis of images from the Hubble Space Telescope, allow him to “see how the individual galaxies behave.”