# THE DARK LAB

## To put general relativity to the acid test, researchers are looking inward—toward the supermassive black hole at the center of the Milky Way

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Like an Olympic athlete, the general theory of relativity has passed many tests in its century-long career. Its string of successes began in 1915, when Albert Einstein's picture of gravity as curved spacetime neatly explained shifts in the orbit of Mercury that had vexed astronomers for more than half a century. In recent decades it has faced more exotic and extreme tests, such as explaining why pairs of superdense neutron stars whirling around each other appear to be gradually spiraling toward collision. Here, too, general relativity triumphed: The stars are losing energy at exactly the rate expected if, as the theory predicts, they emit gravitational waves (see p. 1097).

Yet physicists remain unsatisfied. The tests so far have been too easy, they say. The gravitational fields involved have been fairly weak, coming from single stars and bending or slowing light only very slightly. If the theory is going to show cracks, it will be under more extreme, high-field conditions. That matters because—on paper, at least—general relativity isn't the only game in town. Theorists have put forward alternative models for gravity, but in low fields they look identical to Einstein's theory. In strong fields, they begin to change.

Now, searching for a tougher test, researchers are looking toward the center of our galaxy. There, shrouded in dust, lurks a bright, compact source of radio waves known as Sagittarius A* (Sgr A*) for its position in the sky, near the edge of the constellation Sagittarius. Because of the way stars move in its vicinity, astronomers think that Sgr A* marks the dark heart of the Milky Way: a supermassive black hole weighing as much as 4 million suns but crammed into a space smaller than the distance between the sun and Mercury. That black hole produces the most intense gravitational field in our galaxy and so provides a unique laboratory for testing the predictions of general relativity. Over the next few years, using a range of new instruments tuned to infrared light and radio waves—radiation capable of penetrating the clouds of dust and gas around the galaxy's core—astronomers are hoping to see whether Sgr A* is bending relativity beyond the breaking point.

**A black hole distorts the image of a disk of dust and gas around it, courtesy of the special effects team for the film *Interstellar*.**

Two teams of astronomers—one led by Andrea Ghez of the University of California, Los Angeles (UCLA), and the other by Reinhard Genzel of the Max Planck Institute for Extraterrestrial Physics (MPE) in Garching, Germany—are staring at the center of the galaxy more intently than anyone before them. They are tracking a handful of