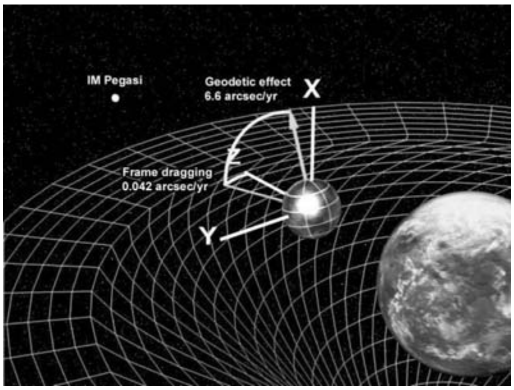
National Aeronautics and Space Administration

The Gravity Probe B Mission

When Einstein produced his revolutionary **Theory of General Relativity in 1916**, perhaps he was able to imagine what curved spacetime looked like by simply looking at the stars and consulting his equations. The evidence for his theory lay in the elegance and congruence of the ideas.

As the 20^{th} century progressed, scientists hoped to test Einstein's theory with experimental evidence. Results from concrete experiments were needed to confirm or revise Einstein's theory of the structure of the universe. But could one actually "see" spacetime? How could one examine the invisible, intangible structure of the universe?

In 1960, Stanford University physicist Leonard Schiff (and, independently, Defense Department physicist George Pugh) suggested that the presence of local spacetime could be "seen" by using **gyroscopes**. If one could float a gyroscope in Earth orbit, the gyroscope, given its natural inertia, would remain fixed in spacetime. If the spacetime itself moved or was curved, the gyroscope would turn with it.



This is how Gravity Probe B experiment works:

1. **A gyroscope and telescope** will be placed in a satellite and sent into a **polar orbit** 400 miles (640 km) above the Earth.

2. The telescope and the gyroscope's spin axis will be **perfectly aligned**, and both will point at a distant star (IM Pegasi).

3. Throughout a year of orbit, the telescope will remain fixed on that distant star. The spinning gyroscope, which will be floating in a vacuum within the satellite, will be allowed to drift with any changes in the local spacetime frame.

4. According to Einstein's theory, the gyroscope should turn in two directions simultaneously. As it travels through curved spacetime, it will turn slightly along one axis. As "frame-dragging" occurs, it will also turn slightly along a perpendicular axis.

5. Schiff calculated that at a 400-mile altitude, spacetime curvature would turn the gyroscope **6.6 arcseconds per year** in one direction, and the "frame-dragging" will turn it **.042 arcseconds per year** in a perpendicular direction.

During the 1-2 years of orbit, delicate sensors will measure the angle that opens up between where the telescope is pointing and where the gyroscope is pointing. The challenge for Gravity Probe B since 1960 has been to invent, develop and build the technology that could measure these miniscule angles in the extreme environment of space and make Schiff's vision a reality.

For more information, comments or questions, contact GP-B at www@relgyro.stanford.edu or visit http://einstein.stanford.edu/

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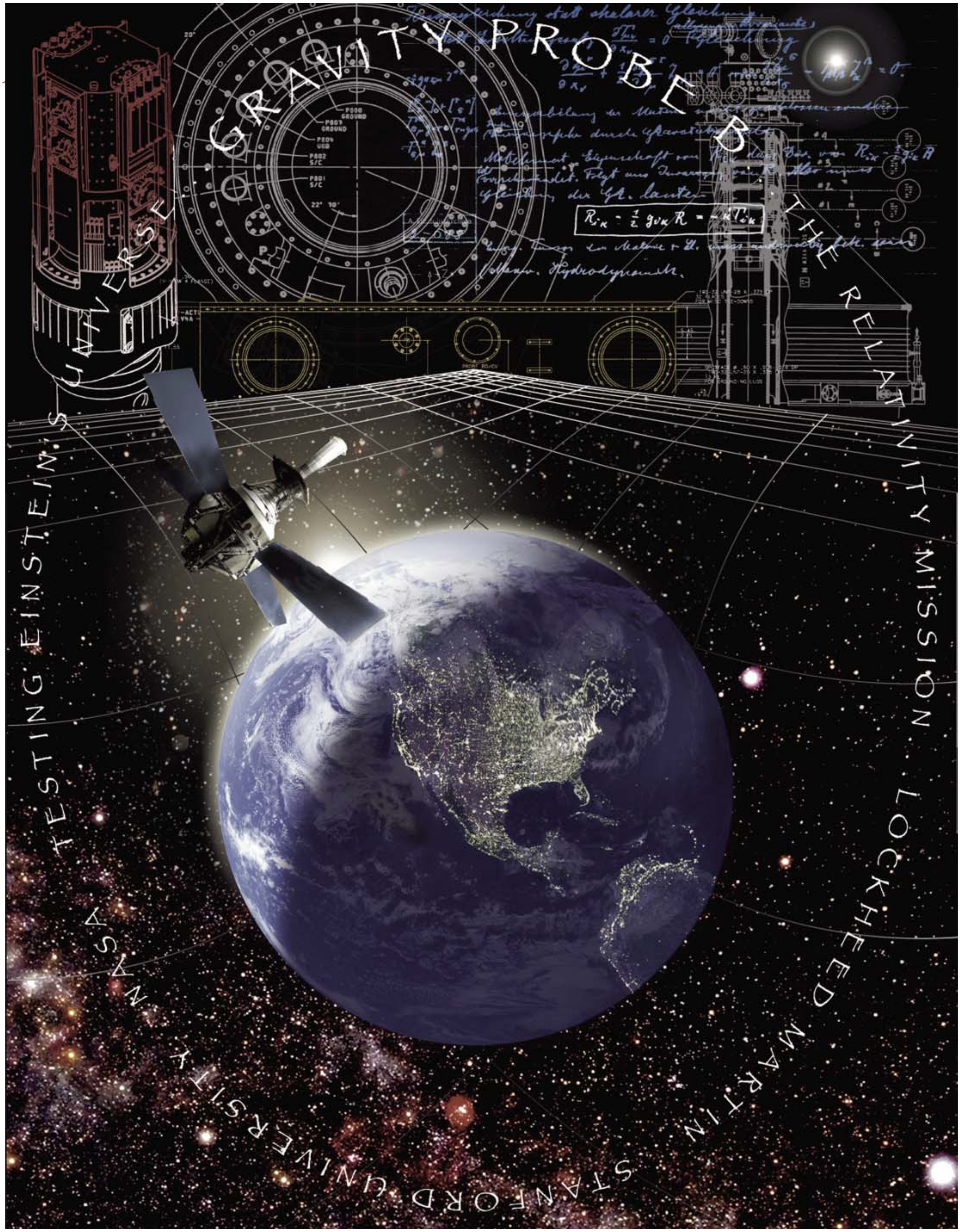

TESTING EINSTEIN'S UNIVERSE
GRAVITY PROBE B
THE RELATIVITY MISSION
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