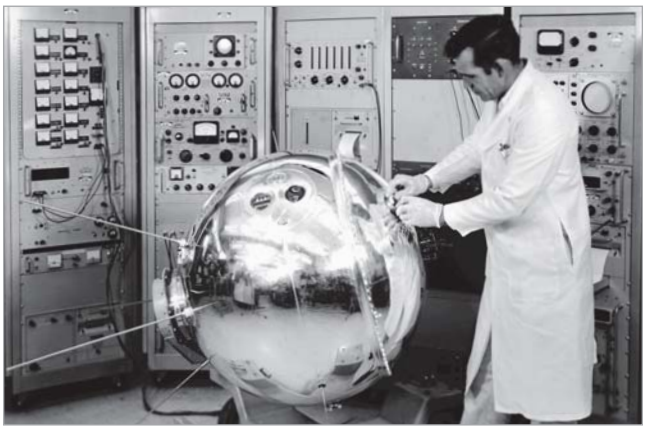
Difficult decisions

Charles Day

Launched on 31 January 1958 by the Army Ballistic Missile Agency, *Explorer 1* was the first US spacecraft to orbit Earth. Besides serving as the first entry in America's Cold War space race with the Soviet Union, *Explorer 1* revealed that our planet is surrounded by a torus of magnetically confined energetic particles, the Van Allen belt.

The torpedo-shaped *Explorer 1* weighed 14 kg and was 2 m long. In the decades since its launch, spacecraft have become bigger, longer-ranged, and more capable. Despite that trend, NASA has retained a program for small- and medium-sized missions since the agency's founding in July 1958. It kept the Explorers name and has sustained the program's record of scientific achievement.



NASA

EXPLORER 17 was launched on 3 April 1963 to study Earth's atmosphere.

Two missions exemplify the success of the Explorers program. In 1994 the *Cosmic Background Explorer* (*COBE*, also known as *Explorer 66*) proved that the spectrum of the cosmic microwave background is that of an almost perfect blackbody. In the following decade, the *Wilkinson Microwave Anisotropy Probe* (*WMAP*, or *Explorer 80*) measured with far higher precision the spatial anisotropies in the CMB that *COBE* had discovered. In doing so, *WMAP* helped to validate and refine the prevailing theoretical model of the universe.

Not surprisingly, scientists compete vigorously to get their missions accepted into the Explorers program. On 9 August NASA announced which 3 of 10 proposers for MIDEX, the top category of Explorers program, would receive $2 million to further develop their proposals and vie for the single, winning slot.

The three finalists are compelling. Arcus is an x-ray astronomy mission whose telescope resembles an insect's compound eye. Because of its large collecting area, the telescope will be able to perform spectroscopy at both high resolution and high sensitivity. Among Arcus's objectives is figuring out how the winds of plasma that emanate from black holes affect their galactic hosts. FINESSE will look at exoplanetary systems whose low-inclination orbital planes cause planets to pass in front of their stars. The transits provide the means to measure the spectra, and therefore the composition and condition, of the exoplanets' atmospheres. SPHEREx will perform an all-sky near-IR spectral survey to create a three-dimensional map of nearby galaxies. The distribution of galaxies bears the imprint of the past expansion of the universe and, it is hoped, enough information to test theories of dark energy.

How to choose among the three missions? One selection criterion is importance. At PHYSICS TODAY, we evaluate what papers to write about based on the magnitude of the questions they purport to address. Among the Big Questions are the following: What does quantum mechanics mean? How did life begin? How does the brain work? How can gravity be united with the other fundamental interactions?

Another is feasibility. In my past career as an astrophysicist, I evaluated observing proposals by running simulations. Some proposals tackled such important questions as whether the observed diversity of active galactic nuclei is due not to intrinsic differences but to viewing angle. But it's hard to say much about that question if the signal-to-noise ratio is too low to yield conclusive spectra.

Then there's the criterion of interest. On page 26 of this issue, you'll find a news story about the biophysics of squid eyes. Somehow, evolution has worked out how to endow the squid's spherical lenses with a refractive index that varies with radius in a way, first worked out by James Clerk Maxwell in 1854, that ensures the lens is free of spherical aberration. The work is hardly of cosmic importance, yet it's undoubtedly interesting.

In evaluating the three MIDEX finalists, NASA should heed public interest in what the missions might discover. The taxpaying public, after all, will foot the bill. What scientists find interesting and curious should also be taken into account. The importance of the variously sized bills of Galápagos finches or the presence of a dark line in the Sun's optical spectrum was not initially apparent. PT