3 Questions: Richard Binzel on astronomers' powerful new tool

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The first Pan-STARRS telescope, PS1, obtained this image of the galaxy M51 and its companion, NGC5195, while it was undergoing commissioning and debugging in 2008. Astronomers announced last month that PS1, which will scan the heavens each night in search of potential threats to Earth, is now fully operational. Image courtesy of Pan-STAARS

Last month, it was announced that the first Pan-STARRS (Panoramic Survey Telescope & Rapid Response System) telescope, PS1, is fully operational. The system is designed to search for “killer” asteroids and comets by mapping large portions of the sky each night to look for moving objects in our solar system.

Based in Hawaii, Pan-STARRS features the world's largest digital camera — a 1,400-megapixel device designed by researchers at MIT Lincoln Laboratory. Follow-up observations based on those images will allow astronomers to track moving objects and calculate their orbits to determine any potential threats to Earth. Richard Binzel, professor of planetary sciences in MIT's Department of Earth, Atmospheric and Planetary Sciences, discusses Pan-STARRs with MIT News. A member of NASA's Task Force for Planetary Defense, Binzel believes that Pan-STARRS' "constant watch" will not only rule out possible threats from near-Earth objects (NEOs) over time, but will also reveal unknown galaxies and details about faraway planets.

Q. How does the technology of Pan-STARRS compare to that of the Hubble Space Telescope *that was launched into orbit in 1990 to study objects in space?*

A. Pan-STARRS and Hubble are about as different as different can be in the way they go about their space studies. Hubble is designed to focus intensely on a very small piece of the sky to unravel the physical mysteries of very carefully pre-selected targets. Pan-STARRS is designed to see as much of the sky as possible as quickly as possible by imaging a huge chunk of the sky every 30 seconds before moving on to a different chunk of the sky. By repeating the image of each part of the sky every few minutes and then comparing those images, Pan-STARRS is designed to detect rapid changes that could indicate a moving object.

It is not known in advance what each Pan-STARRS image will reveal, but there is always something to be discovered with each new look. In most cases, these discoveries will be moving objects — small bodies in our solar system that are following their own orbital paths around the sun. Most are asteroids in the main belt between Mars and Jupiter. Some are in the outer solar system in the new zone of bodies now known to reside beyond Neptune called the Kuiper Belt. Small solar system bodies that are found to be moving the fastest — because they are closer to both the sun and Earth — are the so-called "near-Earth objects" (NEOs). These bodies can be both asteroids and comets whose orbits bring them within the vicinity of Earth, and some have the potential to be on collision course with Earth. By repeatedly imaging these objects over several hours and many nights, their orbital paths can be determined with increasing precision. Fortunately, almost all NEOs can be immediately ruled out for having any potential hazard to Earth. But for those that do show some remaining chance of a future collision, dedicated follow-up tracking by Pan-STARRS or other telescopes can find out for sure. So far, no object with a certain impact having hazardous consequences has been discovered or is known.

Q. What are the limitations of this telescope? Can it be used to find exoplanets — planets that orbit a star other than the sun — or other objects outside our solar system?

A. Pan-STARRS is most strongly specialized toward finding changes in the sky, but unraveling the cause of those changes will largely fall to specialized telescopes to analyze light from different parts of the spectrum or with much higher resolution. Pan-STARRS' strength is being sensitive to any changes it sees anywhere in its field of view, and that, of course, also includes distant stars and galaxies beyond our solar system. While our sun is a very stable light source, many stars pulsate in their brightness in the early and late stages of their lives. Pan-STARRS will be the most sensitive survey ever performed to detect these changes over very short (minutes to hours) to very long (days and years) intervals of time. Pan-STARRS can also detect abrupt, but regularly spaced drops in the brightness of stars that can be a telltale sign of exoplanets. These drops occur when the orbit of the planet happens to carry the planet into the line of sight between us and its own star. Even though we cannot see the planet directly, we can tell that it is there, allowing follow-up observations by Pan-STARRS and other telescopes to learn more about these newly discovered exoplanets. Even farther away, enormous stellar explosions called supernovae can sometimes bring faint galaxies into view that may have never before been seen. All told, the universe is a bizarre and dramatic place, and with the constant watch that Pan-STARRS is giving us, there are plenty of unexpected surprises ahead.

Q. Even with technology like that used in Pan-STARRS, is it possible that we could fail to detect potentially dangerous asteroids or comets?

A. No single system is complete and can be sure to catch every object that is out there. Pan-STARRS' task is to reduce risk by cataloging as many potentially hazardous asteroids and comets as possible. As Pan-STARRS starts out, nearly every discovered asteroid and comet will be a new object that has never before been seen or catalogued. As the survey continues for many years or even a decade, it will begin to "rediscover" objects that are already in the catalog. When Pan-STARRS reaches the point where 90 percent of the asteroids and comets it detects are already in its catalog, we can estimate that about 90 percent of potentially hazardous asteroids and comets have been found. This allows us to know with certainty that the overall risk to Earth is reduced because most objects that we could not know for sure whether they might be hazardous will be safely ruled out. Most importantly, specific objects that might pose a future risk will be positively identified, and resources to fully assess that risk can be focused on these objects to determine whether they are "friend or foe." The odds favor that nearly all will be ruled out as foes, but in identifying them as friends, these objects with the near-Earth orbits have the possibility to be very easily reached for scientific exploration by robotic or human space missions.

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