A hundred million points of light

Covering a quarter of the sky, the Sloan Digital Sky Survey has a bright future as a key astronomical resource, says Govert Schilling.

SDSS

Star tracking: after dark, Apache Point's 2.5-metre telescope emerges from its housing (inset) to scan the sky.

Every day, a sliver of the Universe travels from the Apache Point Observatory in New Mexico to the Fermi National Accelerator Laboratory near Chicago. By express courier, a computer tape bearing one night's observations made by the Sloan Digital Sky Survey's 2.5-metre telescope is ferried to Fermilab's Feynman Computing Center. In five years time, these observations will cover a quarter of the sky and will have been collected into one of the largest scientific databases ever produced — totalling some 15 terabytes (15 million megabytes) of data.

Already, astronomers are aware of the survey's importance for studying faint objects such as distant quasars, and for examining the large-scale structure of the Universe. But the project's leaders believe that the field has yet to grasp the survey's wider significance. According to team member Bruce Margon of the University of Washington in Seattle, the Sloan survey will mark a shift towards a new way of doing astronomy. For many projects, he claims, it will no longer be necessary to book time on leading telescopes. "You will never leave your desk, but just tap into the Sloan archive," he says.

The Sloan Digital Sky Survey began gathering data in 1998, but it will be officially dedicated in a ceremony at Apache Point on 6 October. The survey is valuable because it will record data on the brightness of more than 100 million celestial objects at five different wavelengths, or colours. This should give researchers in just about every subfield of astronomy a wealth of data to work with. "Sloan includes every type of observation an astronomer might want to do," argues Margon. "This is the first time we have had a digital archive with such capability."

The project will also use spectroscopy to record the redshifts — and so work out the distances from the Earth — of one million galaxies, providing a three-dimensional map of our cosmic neighbourhood. "They have 20,000-plus in the can already," says John Huchra of the Harvard-Smithsonian Center for Astrophysics in Cambridge, Massachusetts.

This spectroscopic survey was the original motivation for the project. It will let astronomers study the Universe's large-scale structure by mapping the distribution of the galaxies. But the survey's photometric data might also play a role. For distant galaxies, instead of using time-consuming spectroscopy to measure redshifts, astronomers will be able to generate 'photometric redshifts' from Sloan's five-colour brightness data. Although this could result in galaxies with unusual colours being assigned incorrect redshifts, it offers a rapid way of getting redshifts for large numbers of galaxies.

So far, many of the Sloan survey's highest-profile discoveries have come from expected quarters, such as the study of distant quasars — very remote galaxies with bright cores, probably powered by massive black holes. Michael Turner of Fermilab, the scientific spokesman for the survey, boasts that eight of the ten most distant quasars known — including the current record-holder[1] — were bagged by Sloan. "We've found 2,000 quasars so far," he adds.

The survey is also yielding a rich haul of solitary brown dwarfs, faint objects that are too massive to be classed as planets but not sufficiently large to burn as stars[2,3].

But Bob Hanisch of the Space Telescope Science Institute in Baltimore predicts that the most important scientific results will come from unexpected angles, as astronomers start playing around with the Sloan survey data. "Large-scale statistical studies will point out new classes of objects that can be studied in more detail with large telescopes," says Hanisch. "We're on the threshold of a new revolution that will have a very broad impact."

Piero Benvenuti of the European Southern Observatory in Garching, Germany, agrees. The Sloan is the most ambitious of several survey and data-archiving projects, operating at a variety of wavelengths, he says. If these can be merged and extended, astronomers could mine 'old' data for most of their work, and state-of-the-art telescopes could be devoted exclusively to projects that need their unique capabilities.

US astronomers now want to build a National Virtual Observatory incorporating the Sloan and other surveys. And in the long-term, this might become a truly global initiative. The reward, predicts Benvenuti, will be "a giant leap in efficiency". ■

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