"Field of Streams" found in Milky Way

SLOAN DIGITAL SKY SURVEY NEWS RELEASE
Posted: May 9, 2006

A new map of stars in the Milky Way Galaxy, constructed with data from the Sloan Digital Sky Survey (SDSS-II), reveals a night sky criss-crossed with streams of stars, left behind by satellite galaxies and star clusters spiraling to their deaths.

Analyzing five years of data spanning nearly one-quarter of the sky, Cambridge University (UK) researchers Vasily Belokurov and Daniel Zucker created a dramatic new image of the outer Milky Way, using stellar colors eliminating the redder, nearby stars that would otherwise swamp the view of background structures. They found so many trails of stars in their high contrast image that they named the area the "Field of Streams."

Satellite galaxies orbiting the Milky Way are literally ripped apart by the tidal forces of our galaxy. As these satellites sink in gravitational quicksand, their stars are torn from them in giant streams that trace their orbital paths -- just like meteor streams lie along the paths of defunct comets in the Solar system.

Dominating the Field of Streams image is the enormous, arching stream of the Sagittarius dwarf galaxy. The Sagittarius dwarf was discovered more than a decade ago and other researchers have previously mapped its long tidal stream in other regions of the sky.

But the new SDSS-II data had a remarkable surprise in store.

"The stream appears forked," said Belokurov. "We are seeing different wraps superimposed on the sky, as the stream goes around the galaxy two or three times."

Because of the multiple wraps, the observations provide strong new constraints on the dark matter halo of the Milky Way, according to Mike Fellhauer of Cambridge University. "The leading theories of dark matter predict that the Galaxy's halo should be flattened, like a rugby football. But our simulations only match the forked Sagittarius stream if the inner halo is round, like a soccer ball."

In addition to the Sagittarius arches, the Field shows faint trails of stars torn from globular clusters, and other rings, trails, and lumps that appear to be the remains of disrupted dwarf galaxies. "There are more streams here than in a river delta," commented Zucker.

Prominent among these is the Monoceros stream, discovered

previously by SDSS-II scientists Heidi Jo Newberg of Rensselaer Polytechnic Institute and Brian Yanny of the Fermi National Accelerator Laboratory. The multiple rings of stars are all that remain from a dwarf satellite that was absorbed by the Milky Way long ago.

Crossing the Field is an enigmatic, new stream of stars extending over 70 degrees on the sky, whose original source remains unknown.

"Some of these 'murdered' galaxies have been named," explained SDSS-II team member Wyn Evans of Cambridge, "but this galactic corpse hasn't been identified yet. We're looking for it right now."

These new discoveries add weight to a picture in which galaxies like the Milky Way are built up from the merging and accretion of smaller galaxies.

"We've known about merging for some time" said Yanny, "but the Field of Streams gives us a striking demonstration of multiple merger events going on the Milky Way galaxy right now. This is happening all over the Universe, as big galaxies grow by tearing up smaller ones into streams."

These streams also provide new tests of the nature of dark matter itself, according to theorist James Bullock of University of California at Irvine; Bullock was not part of the SDSS team.

"The fact that we can see a 'Field of Streams' like this suggests that dark matter particles are very 'cold', or slow moving. If the dark matter was made up of 'warm,' fast moving particles, we wouldn't expect these thin streams to hang around long enough for us to find them."

The Sloan Digital Sky Survey (SDSS-II) addresses fascinating, fundamental questions about the universe. With the survey, astronomers will be able to see the large-scale patterns of galactic sheets and voids in the universe. Scientists have varying ideas about the evolution of the universe, and different patterns of large-scale structure point to different theories of how the universe evolved. The Sloan Digital Sky Survey will tell us which theories are right -- or whether we have to come up with entirely new ideas.

Funding for the SDSS and SDSS-II has been provided by the Alfred P. Sloan Foundation, the Participating Institutions, the National Science Foundation, the U.S. Department of Energy, the National Aeronautics and Space Administration, the Japanese Monbukagakusho, the Max Planck Society, and the Higher Education Funding Council for England.

The SDSS is managed by the Astrophysical Research

Consortium for the Participating Institutions: The American Museum of Natural History, Astrophysical Institute Potsdam, University of Basel, Cambridge University, Case Western Reserve University, University of Chicago, Drexel University, The Fermi National Accelerator Laboratory, the Institute for Advanced Study, the Japan Participation Group, The Johns Hopkins University, the Joint Institute for Nuclear Astrophysics, the Kavli Institute for Particle Astrophysics and Cosmology, the Korean Scientist Group, the Chinese Academy of Sciences (LAMOST), Los Alamos National Laboratory, the Max-Planck-Institute for Astronomy (MPA), the Max-Planck-Institute for Astrophysics (MPIA), New Mexico State University, Ohio State University, University of Pittsburgh, University of Portsmouth, Princeton University, the United States Naval Observatory and the University of Washington.