Newly Discovered Olympian Galaxy Will Provide Fresh Insights into Galactic Formation

May 30 2007

A newly discovered dwarf galaxy in our local group has been found to have formed in a region of space far from our own and is falling into our system for the first time in its history.

The dwarf is formally known as Andromeda XII because it is the 12th dwarf galaxy associated with Andromeda, our nearest galactic neighbor. The discoverers have nicknamed it the Olympian Galaxy after the 12 Olympian gods in the Greek pantheon. The discovery was made possible with data obtained at the W. M. Keck Observatory atop Mauna Kea, Hawaii.

According to Andrew Blain, an astronomer at the California Institute of Technology and a member of the discovery team, the Olympian Galaxy marks the best piece of evidence that at least some small galaxies are just now arriving in our local group, which primarily includes the Milky Way, Andromeda, and various dwarf galaxies in the vicinity of both. The finding provides an important test for simulations of galaxy formation.

Dwarf galaxies and streams of stellar material mark the visible remnants of galactic merging events from which large galaxies are made. Cosmology models predict that small galaxies form along a web of filamentary structures in the universe and then gradually fall into dense groups and cluster environments. Small galaxies should still be falling into the local group, yet none have been found--until now.

"Other local group dwarf galaxies are thought to have extreme orbits, including Leo I, Andromeda XIV and Andromeda XI, but the Olympian Galaxy really stands out as a contender for a new entrant into the local group," says the lead author of the study, Scott C. Chapman of the University of Cambridge Institute of Astronomy. "The others have likely already been seriously harassed by Andromeda and the Milky Way."

The Olympian Galaxy was first discovered in October 2006 during a wide-field survey taken with the Canada-France-Hawaii Telescope's MegaCam instrument. It is the faintest dwarf galaxy ever discovered near Andromeda (also known as M31), and may have the lowest mass ever measured. Dwarf galaxies are the smallest stellar systems showing evidence for a substantial amount of dark matter.

Chapman's observations confirmed that the Olympian Galaxy is distinct from all other satellite galaxies in the local group. It is a fast-moving galaxy on a highly eccentric orbit, located at a great distance-about 115 kiloparsecs (375,000 light-years)-from the center of M31. Importantly, the Olympian Galaxy lies significantly behind M31 as viewed from the Milky Way, which indicates that it is almost certainly falling in for the first time. Because the dwarf galaxy has lived its life in a very different environment from that of the local group, it gives astronomers a pristine object for studying star-formation histories, dark-matter distribution, and other parameters that would be influenced by the local-group gravity that has affected other dwarf galaxies.

"The Olympian Galaxy may be the first galaxy of the local group ever observed that has not yet been disrupted by the strong gravity of the local group," says Jorge Penarrubia of the University of Victoria, a coauthor of the study.

The Deep Extragalactic Imaging Multi-Object Spectrograph (DEIMOS) at Keck II, one of two 10-meter telescopes the W. M. Keck Observatory

operates on the summit of Mauna Kea, was key in making the discovery. It was used to observe 49 stars in the region of the Olympian Galaxy, and confirmed that eight were members of the new dwarf galaxy. Follow-up observations were also conducted at the Green Bank Telescope in West Virginia to measure the amount of interstellar gas in the galaxy, and the Subaru telescope in Hawaii helped determine a more precise distance.

"Without the spectra we obtained with DEIMOS, it would have been impossible to make any useful claims about the orbit of the Olympian Galaxy, its evolution, its speed, or its dark-matter content," adds Chapman.

The Olympian Galaxy is falling very quickly through the local group from behind Andromeda, and is the only one of Andromeda's satellites that exceeds the apparent escape velocity for Andromeda. It is possible that the Olympian Galaxy may be just a short-term visitor. It is such a low-mass galaxy that it may not slow down much as it passes through the local group.

"It is a pleasure to see the speed of this new, fascinating member of the local group clocked using Keck II and DEIMOS," adds W. M. Keck Observatory director Taft Armandroff. "The powerful combination of Keck and DEIMOS has added many contributions to our understanding of local-group galaxies."

The age of the universe is not old enough for the Olympian Galaxy to have started in the dense local group and be on its second trip through our system. The dwarf galaxy probably formed in a dense filament structure, toward the general direction of the M81 group. However, the distance to that group is about three times too far for the galaxy to have actually come from there. A likely scenario is that the Olympian Galaxy formed in a filamentary region of space that connects the local group to the M81 group.

"The high speed really surprised me; I wasn't expecting to see any of our newly discovered dwarfs moving so fast. We will likely have to revise our mass estimates of Andromeda upward as a result," adds Rodrigo Ibata, another author of the study.

A paper reporting the discovery, "Strangers in the Night: The Discovery of a Dwarf Spheroidal Galaxy on its First Local Group Infall," will appear in an upcoming issue of the Astrophysical Journal. Funding was provided by a fellowship from the Canadian Space Agency and the Natural Sciences and Engineering Research Council of Canada. Additional support was provided by Adrian Jenkins, who made available important computer simulations.

The study was coauthored by Jorge Penarrubia, Alan McConnachie, and Aaron Ludlow of the University of Victoria; Rodrigo Ibata, Observatoire de Strasbourg; Nicolas F. Martin, Max-Planck-Institut für Astronomie; Andrew Blain and Bruno Letarte, California Institute of Technology; Michael Irwin, University of Cambridge Institute of Astronomy; Geraint Lewis, University of Sydney Institute of Astronomy; Fred Lo and Karen O'Neil, NRAO Green Bank Telescope.

Source: University of California