Stars Evolve Rapidly, Violently in Ultra-luminous Infrared Galaxies

February 16 2006

The discovery makes the fiery environment within a typical spiral or starburst galaxy look almost pastoral. Cornell researchers using the Spitzer Space Telescope say distant galaxies contain an inferno of very young, massive and violently evolving stars, packed together in tiny but extremely powerful cosmic globs.

The key to the discovery, paradoxically, is in the presence of delicate, glittery crystalline silicates called Forsterite. These are glassy particles that exist in the debris disks of young stars and in the stellar wind of very old stars, but which have never before been observed in the mass of gas and dust known as the interstellar medium, or ISM, in the Milky Way or in any other galaxy.

The research, led by Cornell astronomer and Spitzer Fellow Henrik Spoon, will appear in the Feb. 20 issue of the *Astrophysical Journal*.

Using Spitzer's infrared spectrograph (IRS), an instrument developed by a team led by Cornell professor of astronomy James Houck and built at Cornell, Spoon and colleagues observed dozens of distant galaxies known as ultra-luminous infrared galaxies (ULIRGs). First discovered in large numbers in 1982, most ULIRGs are thought to form as two or more spiral galaxies collide (as our galaxy will, in a few billion years, with the nearby Andromeda galaxy), and their leftover hydrogen gas fuels the fierce, rapid formation of massive stars.

ULIRGs are relative runts in galactic terms (though some have sweeping tidal tails), with the source of their luminosity coming from an area as small as one-hundredth that of typical galaxies. Seen with an optical telescope, they look dusty, chaotic and unspectacular. But in the mid-infrared spectrum, said Spoon, "they are booming," appearing up to 100 times more luminous than a spiral or starburst galaxy.

Silicates are the most common types of minerals in the Milky Way, so their presence in ULIRGs is not surprising. But among the silicates, most (95 percent in the immediate vicinity of rapidly evolving stars and at least 99 percent in the general ISM) are amorphous in structure.

Spoon and his team saw the expected broad absorption features of amorphous silicates in the infrared spectra of the ULIRGs they observed. But they also saw signature narrow dips within the broad bumps indicating the presence of silicates in crystalline form in the general ISM. The concentration of crystalline silicates in at least 21 ULIRGs, Spoon found, is seven to 15 times greater than in any other known environment.

In our galaxy, crystalline silicates have only been observed close to active new stars, which inject them into their immediate environment as they evolve, and in the exhaled winds of dying stars. Subject to heavy pummeling by destructive cosmic and shock-accelerated ions, the silicates quickly lose their ordered, crystalline structure and take an amorphous shape.

"We were surprised to find such delicate little crystals in the centers of some of the most violent places in the universe," said Spoon. "Given the rapid transformation of crystalline silicates to an amorphous state, the injection rate of freshly produced crystalline silicates must be far higher than in our galaxy. We're probing exotic circumstances."

Spitzer's IRS, which can record infrared spectra from objects fainter and farther away than ever before, has allowed astronomers to study ULIRGs and other stellar nurseries in new detail.

"Now we can take a good look at what these characteristics are," said Spoon. "It's like, for the first time, you put on a pair of glasses, and -- wow."

Spitzer Space Telescope: www.spitzer.caltech.edu/index.shtml

Source: Cornell University

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