Hubble movies reveal solarsystemsized traffic jams

September 1 2011

(PhysOrg.com) -- When it comes to big-budget action movies, Rice University astronomer Patrick Hartigan prefers Hubble to Hollywood.

Using Hubble Space Telescope images collected over 14 years, Hartigan has created time-lapse movies that offer astronomers their first glimpse of the dynamic behavior of stellar jets, huge torrents of gas and particles that spew from the poles of newborn stars.

An analysis of the movies that was published in The Astrophysical Journal is forcing astronomers to rethink some of the processes that occur during the latter stages of star birth. And in an effort to learn even more, Hartigan and colleagues are using powerful lasers to recreate a small-scale version of the solar-system-sized jets in a lab in upstate New York.

"The Hubble's given us spectacular images," said Hartigan, professor of physics and astronomy at Rice. "In the nebulae where stars are born, for instance, we can see beautiful filaments and detailed structure. We know these images are frozen snapshots in time, but we would need to watch for hundreds of thousands of years to see how things actually play out."

Hartigan said stellar jets are different because they move very quickly. Stellar jets blast out into space from the poles of newly formed stars at about 600,000 miles an hour. Astronomers first noticed them about 50 years ago, and they believe the sun probably had stellar jets when it formed about 4.5 billion years ago.

Hartigan began using Hubble to collect still frames of stellar jets in 1994. The jets emerge from each pole of a young star, and Hartigan used Hubble to revisit the jets from three stars in 1994, 1998 and 2008. All three stars are about 1,350 light years from Earth. Two are near the Orion Nebula, and the third is in the southern sky in the constellation Vela.

By lacing the images together and using a computer to fill in what occurred between still frames, Hartigan and his collaborators created time-lapse movies. The movies clearly showed something that wasn't obvious in any of the still images; clouds of dust and gas within the jets move at different speeds.

"The bulk motion of the jet is about 300 kilometers per second," Hartigan said. "That's really fast, but it's kind of like watching a stock car race; if all the cars are going the same speed, it's fairly boring. The interesting stuff happens when things are jumbling around, blowing past one another or slamming into slower moving parts and causing shockwaves."

Understanding what happens in those huge collisions is another challenge. The phenomena didn't look like anything that Hartigan and his astronomer colleagues had seen. But when he showed them to colleagues who were familiar with the physics of nuclear explosions, they immediately saw patterns in the shockwaves that looked familiar.

"The fluid dynamicists immediately picked up on an aspect of the physics that astronomers typically overlook, and that led to a different interpretation for some of the features we were seeing," Hartigan explained. "The scientists from each discipline bring their own unique perspectives to the project, and having that range of expertise has proved invaluable for learning about this critical phase of stellar evolution."

Motivated by the results from Hubble, Hartigan and colleagues are conducting experiments at the Omega Laser Facility in Rochester, New York, to recreate small-scale versions of the solar-system-sized features captured in the movies.

"It's one more tool we have to better understand the underlying physics," Hartigan said.

More information: Hartigan's Hubble Space Telescope movies are available at: sparky.rice.edu/~hartigan/movies.html

Provided by Rice University