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Embryonic Stars in Hidden Stellar Nurseries

Despite the long history of musings by creative writers, philosophers, and theologians, until the late 20th century, the only planets we were certain existed are those that orbit our Sun[1]. Since then, astronomers have been finding increasing evidence that most stars have planets[2]. This evidence comes from two types of studies – those focused on discovering planets around distant stars, and those focused on studying how stars and planets form in the first place. My own research efforts belong to the latter category.

The cold interstellar clouds of gas and dust that give birth to new stars are trillions of miles across and they rotate slowly. They are also invisible. Fortunately, telescopes that record infrared light and radio waves can not only detect the clouds themselves, they can peer into these hidden stellar nurseries and enable us to develop a picture of how nascent stars develop. As gravity pulls these clouds together, they shrink and flatten out into huge *protoplanetary disks*, comparable to the size of our Solar System ("mere" billions of miles across.) As the name suggests, protoplanetary disks can eventually form planets, given sufficient time and material.

One question that puzzled astronomers for many years is how stars can actually form at the centers of these disks, since they spin faster as they shrink, similar to what happens when spinning figure skaters pull their outstretched arms in toward their bodies. (As a former competitive figure skater, I have first-hand experience of this.) For gravity to build up a star, material falling onto the star from the disk must lose angular momentum (in other words, something has to slow the spin.) This happens through powerful outflows of gas, known as jets, which are channeled into tight streams perpendicular to the disks.

Some fun facts about jets from nascent stars: (1) Jets can travel a million kilometers per hour and launch more than a trillion tons of gas into space every day. (2) Jets are much longer than they are wide. (Their proportions are similar to a garden hose shooting a tight stream of water 20 miles.) (3) Jets span interstellar distances; that is, their lengths can be thousands of times larger than the diameters of the

protoplanetary disks that launch them. Because of this, observations of jets are often used to infer the presence of a disk when the disk itself isn't observed directly.

Although we've put together a fairly detailed picture of how an individual star forms with planets, reality is far more complex. Stellar nurseries tend to be very crowded environments, cranking out clusters of tens or hundreds of stars of various sizes and masses. In fact, we've good reason to think our own Sun was born with many stellar "siblings"[3]. Disentangling all the ways baby stars affect their surroundings is no easy task – even with current technology! The heftiest stars in stellar nurseries bathe their surroundings in intense ultraviolet light that heats and disperses the natal cloud quickly, so many questions remain such as: Do these massive stars form with disks? Do the disks survive long enough to produce planets? How do massive stars affect the development of their siblings?

We are just starting to address some of these questions. My colleagues and I just published a survey of stellar nurseries that reports new evidence of jets originating from nascent massive stars[4]. We expect that learning more about the development of infant stars in clusters will help us better understand the amazing diversity of planetary systems that continue to be discovered.

Until next month,

Grace

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[1] We refer to the Sun and its diverse orbiting worlds collectively as the Solar System.

[2] Planets orbiting other stars are technically known as "exoplanets", but we'll just refer to them as "planets" here.

[3] Check out the Astrobiology News Archive for April 2015 to read more about this.

[4] http://www.adlerplanetarium.org/wp-content/uploads/Adler-Astonomer-Wolf-Chase-Develops-New-Ways-to-Look-at-Stars.pdf