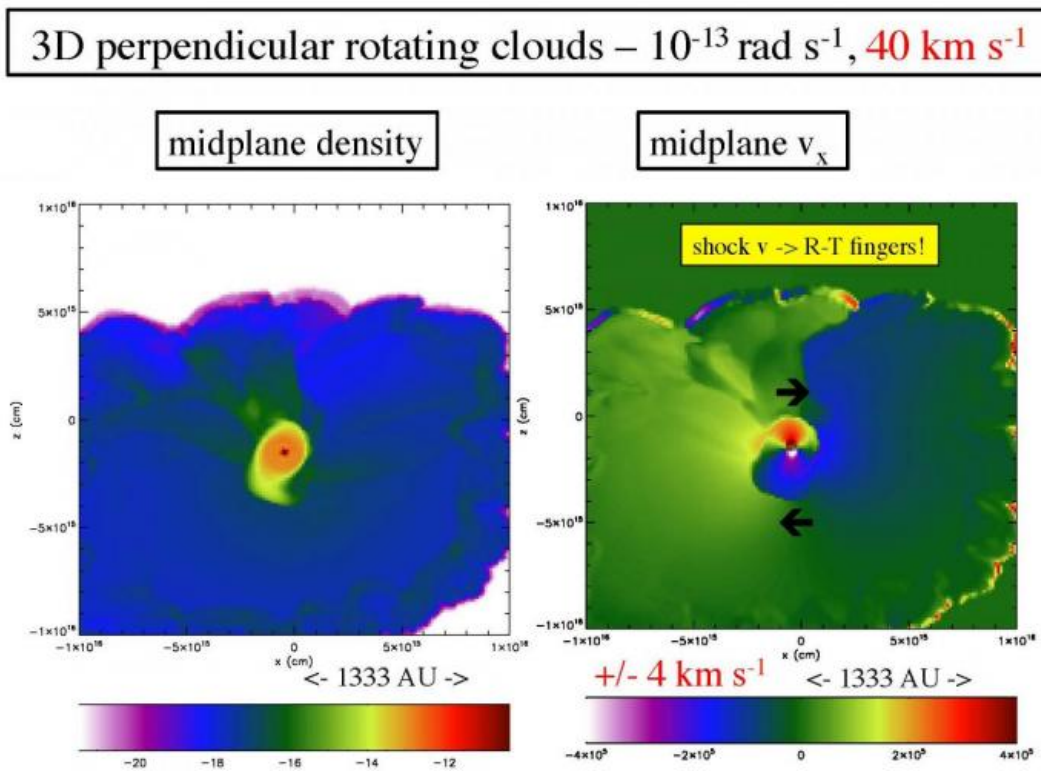


# Solar System formation don't mean a thing without that spin

August 18 2015



These images show the central plane of a rotating disk orbiting a newly formed protostar (dark dot) formed in a three-dimensional model of the shock-triggered collapse of a molecular cloud of gas and dust. On the right you can see how the shock (outer edge) has injected fingers with motions that are responsible for producing the spin of the disk around the central protostar. Image is provided

courtesy of Alan Boss. Credit: Alan Boss

New work from Carnegie's Alan Boss and Sandra Keiser provides surprising new details about the trigger that may have started the earliest phases of planet formation in our solar system. It is published by *The Astrophysical Journal*. For decades, it's been hypothesized that our Solar System's genesis was initiated by a shock wave from a supernova. According to this theory, the wall of pressure formed by a shock wave from the exploding star smacked into a cloud of dust and gas, causing it to collapse and contract into the core of a new proto-star—our Sun. This young Sun was surrounded by a rotating disk of dust and gas that eventually aggregated to form the planets of our Solar System.

Boss and Keiser have explored this theory of cloud collapse—as opposed to a previous theory of shock wave-caused cloud shredding—using advanced 2-D and 3-D modeling for several years and have published a series of papers supporting it.

A crucial aspect of this line of research is the distribution of certain products of the explosion, called short-lived radioisotopes. Isotopes are versions of elements that contain the same number of protons, but different number of neutrons. Specific isotopes were formed during the supernova's explosion and distributed throughout the region that would eventually become our Solar System, before the isotopes had a chance to undergo radioactive decay. Their daughter products can be found today in samples of primitive meteorites.

Previous modeling work from Boss and Keiser demonstrated that a wave of pressure expanding out from a supernova's explosion could have struck a gas cloud, and formed little finger-like indentations in the cloud's surface, which injected the short-lived radioisotopes into the

collapsing ball of gas and dust that would eventually become our Sun and its planets.

The new modeling work from Boss and Keiser shows that this shock injection could have been responsible not only for the distribution of the isotopes now found in primitive meteorites, but also for the spin of our Solar System. The angular momentum of the shock fingers appears to be what allowed the disk of gas and dust to form around the Sun, instead of collapsing into it.

"This was a complete surprise to me," Boss said, "the very fact that a rotating disk formed around our proto-Sun may have been a result of the spin induced by this shock front. Without spin, the cloud disappears into the proto-Sun. With spin, a disk suitable for [planet formation](#) is created."

Provided by Carnegie Institution for Science

Citation: Solar System formation don't mean a thing without that spin (2015, August 18)  
retrieved 26 April 2024 from <https://phys.org/news/2015-08-solar-formation-dont.html>

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