EMBARGOED FOR RELEASE UNTIL
7:00 a.m. PT on Monday, November 5, 2018
MEDIA CONTACTS
Saralyn Stewart
(512) 694-2320
stewart@physics.utexas.edu

Laboratory Experiments Probe the Formation of Stars and Planets

Physicists take a significant step toward understanding the development of heavenly bodies.

PORTLAND, Ore.—The cosmos is a void dotted with stars and an ever-increasing number of newly-observed planets beyond our solar system. Yet, how these stars and planets formed out of clouds of interstellar dust and gas remains mysterious.

The study of black holes provides clues that could help solve this mystery. Black holes are typically depicted as vacuum cleaners sucking up all the nearby matter and light. But in reality, clouds of dust and gas called accretion disks swirl around black holes, gradually moving closer and closer until they fall into the black holes.

Researchers at Princeton Plasma Physics Laboratory helped verify one of the proposed models for how this process works. Their work, supported by NASA, the National Science Foundation, the Department of Energy, the Simons Foundation, the Institute for Advance Study and the Kavli Institute for Theoretical Physics, will be presented at the American Physical Society Division of Plasma Physics meeting in Portland, Ore.

Typical objects orbiting a star, such as the planets going around our sun, continue orbiting for billions of years because their angular momentum remains unchanged, preventing them from falling inward. Such a system's angular momentum is a conserved quantity—it remains constant unless acted on by another force. If for some reason, the angular momentum of an orbiting object decreases, it can fall inward towards the star.

Unlike isolated planets, orbiting matter in a denser, more crowded accretion disk can experience forces, such as friction, that cause it to lose angular momentum. Such collisions, however, are not enough to explain how quickly matter must fall inward to form planets in a reasonable time. But the magnetorotational instability, in which magnetic forces take the place of collisions, can provide an explanation.

Researchers did an experiment simulating this process using a unique rotating water-filled device. Video is recorded of a water-filled red plastic ball as it moves away from the center of the device. A spring in the experiment connects the ball to a post to simulate magnetic forces. Position measurements of the ball indicate that the behavior of its angular momentum is consistent with what is expected of the magnetorotational instability.

Researchers are now conducting experiments using spinning liquid metals to study what happens in accretion disks with actual magnetic forces present. The experiments confirm how strongly the magnetic field affects the metal and pave the way toward a clear understanding of the role the fields play in accretion disks. The combined results mark a significant step toward a more complete explanation of the development of heavenly bodies.

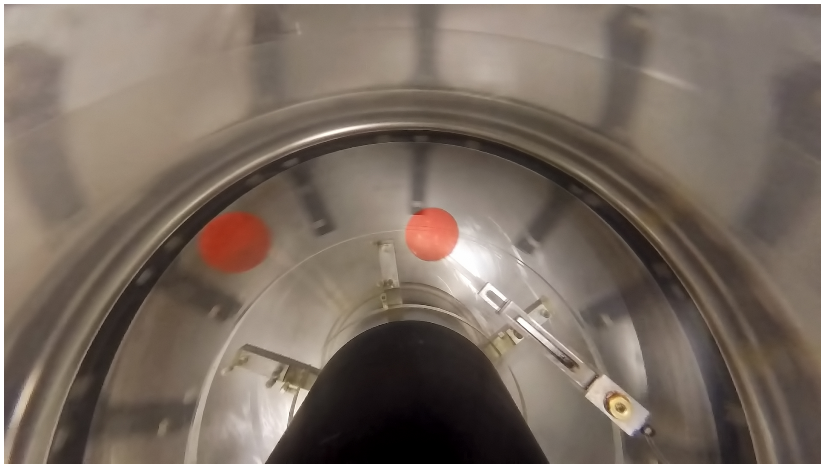

Figure 1: Still of superimposed videos of the mass/spring experiment. In the videos, the untethered sphere moves farthest from the center post and closest to the edge. However, the weakly-tethered mass gains angular momentum while the untethered one does not. The superimposed videos are here. Image courtesy of Derek M. H. Hung.

Contact:
Dr. Erik Gilson, Princeton Plasma Physics Laboratory, egilson@pppl.gov

Abstract

YI3.00006	The Magnetorotational Instability (MRI): Observation in a Mass/Spring System and the Effects of Conductive Boundaries on a Free Stewartson-Shercliff Layer as a Step Towards MRI in a Liquid Metal
Session	YI3: BPP Invited III: Gyrokinetic Modeling, Basic Shocks, EOS, and Laboratory Astrophysics 9:30 AM–12:30 PM, Friday, November 9, 2018 OCC Room: Oregon Ballroom 204

Video from Princeton Plasma Physics Laboratory