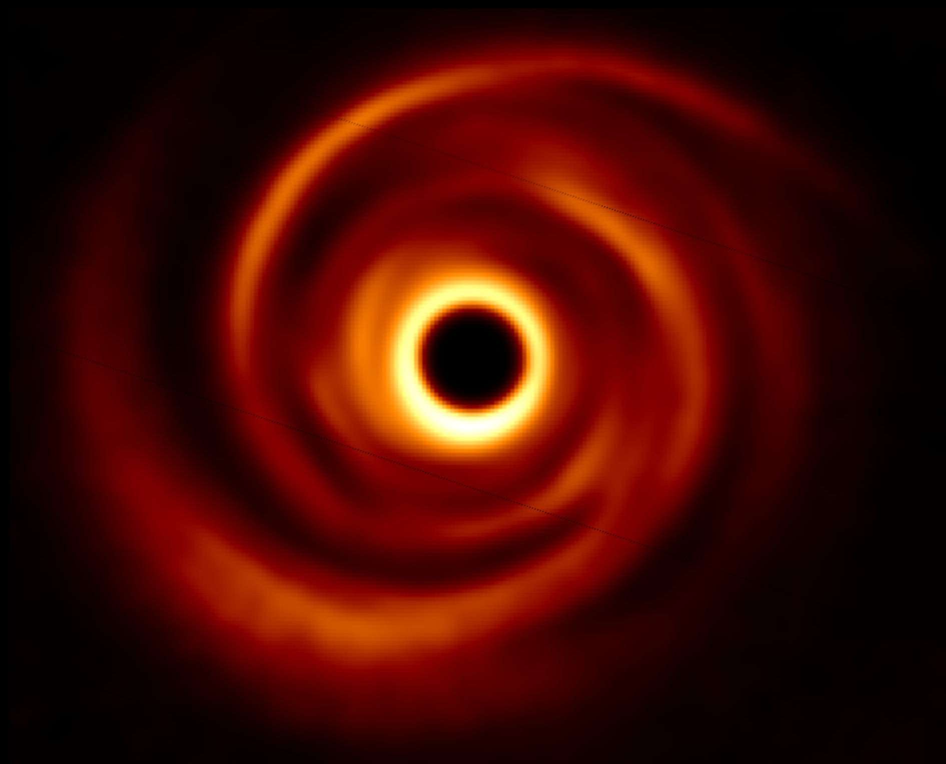
3D Disk-Planet Interaction:
Observable Disk Features and Dynamical Planet Migration



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Simulating 3D Disk-Planet Interaction

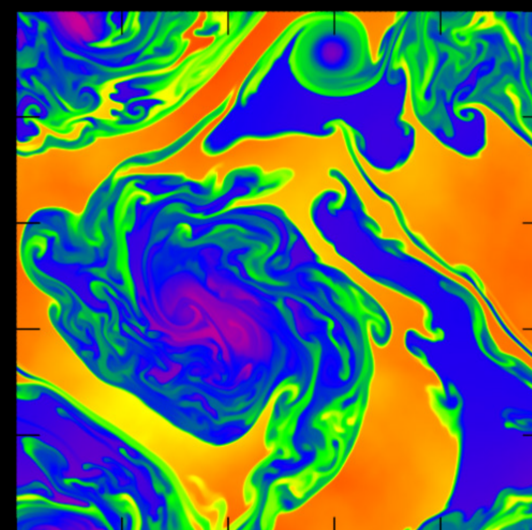
Why

Classical disk-planet interaction theory assumes a thin 2D disk, but protoplanetary disks are 3D in nature, with vertically varying dynamics.

These 3D dynamics are not only important for planet evolution, but also the visibility and shape of disk features.

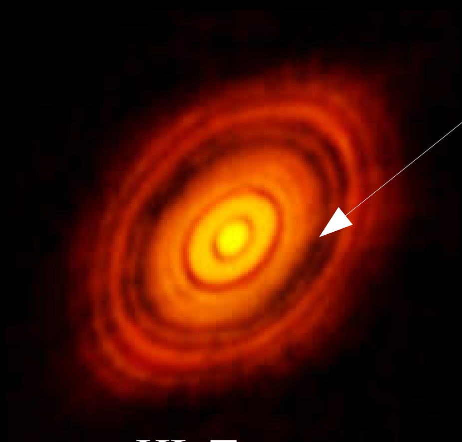
How

3D simulations of protoplanetary disks demand a large amount of computational power. To make them achievable, we utilize GPU (Graphics Processing Units) acceleration in our hydrodynamics code PEnGUIn.



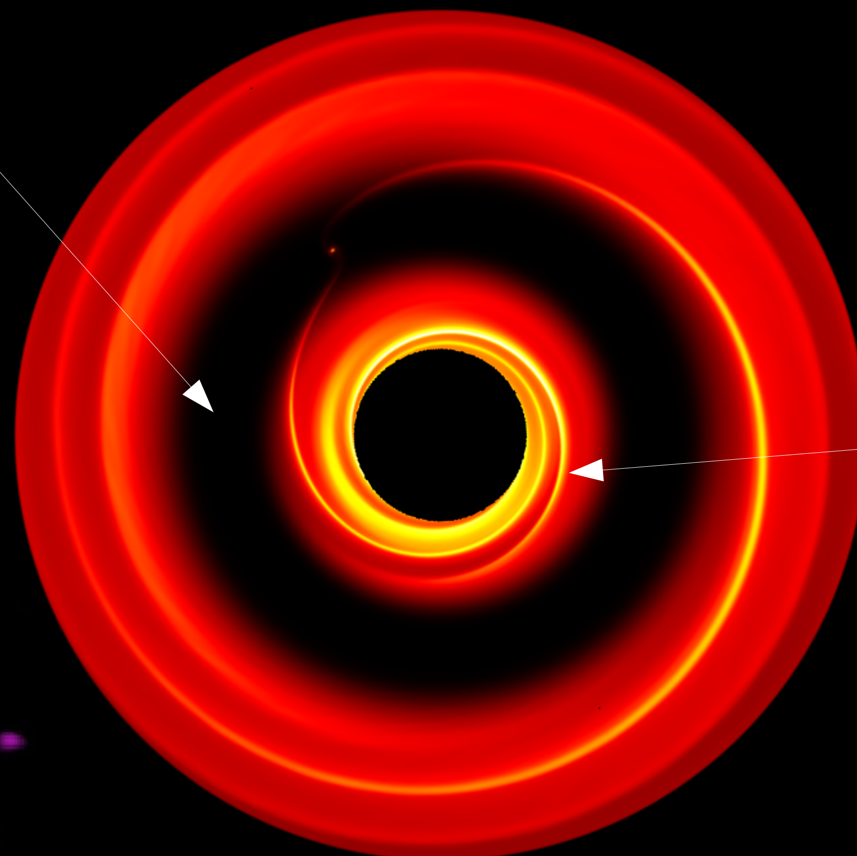
PEnGUIn runs 3D simulations at a speed of about 100 million cells per second on a single desktop computer. The bird sure can swim!

3D simulations of disk-planet interaction will help us link disk features to their possible planetary origins

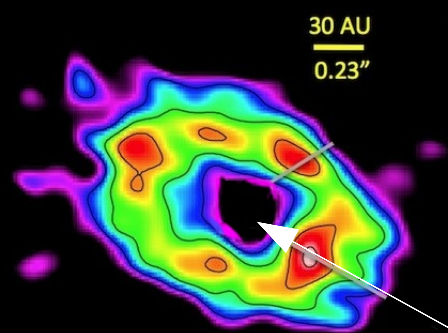


HL Tau
(Partnership et al. 2015)

gaps

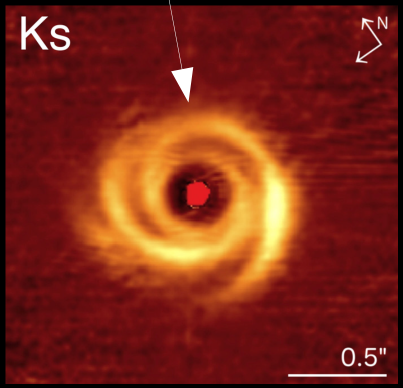


spirals



LkCa 15
(Isella et al. 2012)

inner cavity
(multi-planet gap?)



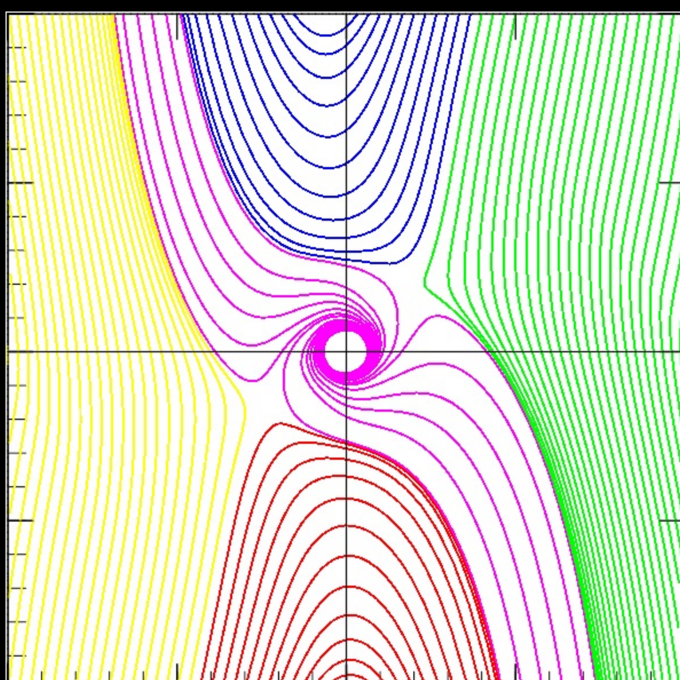
SAO 206462
(Garufi et al. 2013)

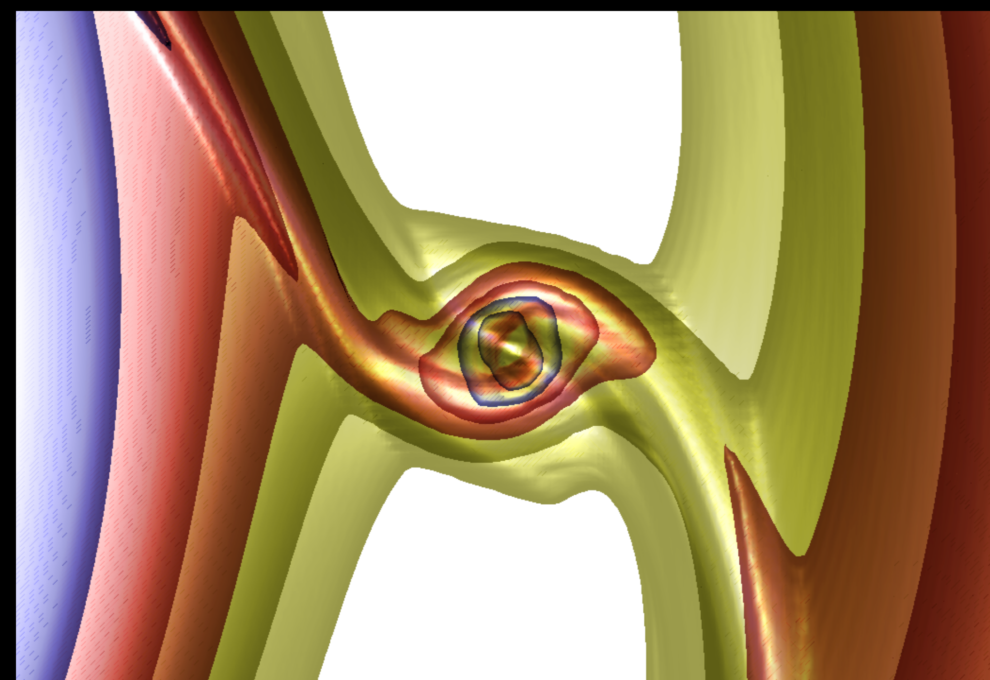
We aim to devise methods that will allow us to infer planets' physical and orbital properties from disk features such as spirals and gaps.

They will also reveal
the 3D flow dynamics around a planet and how that influence the planet's evolution

Planet migration theory have so far ignored disk-planet interaction at very short distances from the planet, of order the planet's Hill radius.

We have found that inside the planet's Hill sphere, both the 3D flow topology and 3D density structure are highly complex.





At these distances, small asymmetries can lead to a large impact on the planet's orbital evolution. It is our goal to understand these impacts, and quantify their effects.