

## Was the outer solar system shaped by a stellar fly-by?

Computer modelling suggests that – billions of years ago, when our solar system was young – a star swept near, stealing some of our sun's material and creating the odd orbits of Kuiper Belt objects.

How do we know how our solar system was born?

Astronomers look outward to see other solar systems in the process of formation. They also use the tools of modern astronomy – physics and high-powered computers – to create possible scenarios of the formation of our Sun, Earth and other nearby planets. And then they look closer to home, trying to see if their computer models match what's observed in our solar system. In this way, over decades, astronomers have built up the scenario of our solar system evolving from a disk of gas and dust in space. But the models, of course, never match the reality precisely.

One mystery has been that the cumulative mass of all objects beyond Neptune – in what is known as the Kuiper Belt – is much smaller than expected. Plus, the bodies there have mostly inclined, eccentric orbits in contrast to the orbits of the major planets, which are all more or less in a single plane, and more nearly circular. This month, **Susanne Pfalzner** from the Max Planck Institute for Radio Astronomy in Bonn, Germany, and her colleagues presented a new study – based on computer modelling – showing that a close fly-by of a neighbouring star – which, according to this model, might have happened billions of years ago, when our solar system was forming – can explain some of these mysteries. It can explain both the observed paucity of objects in the outer part of the solar system and the eccentric, inclined orbits of those objects.

What's more, this new work shows that many additional bodies at high inclinations still await discovery, perhaps including a sometimes postulated Planet X.

In the peer-reviewed *Astrophysical Journal* on August 9, 2018. Pfalzner said in a statement:

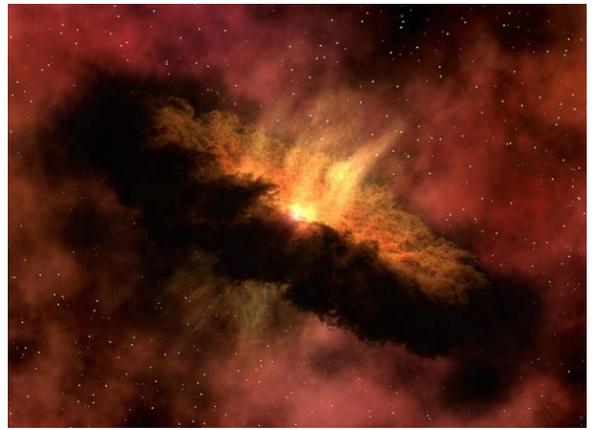
*Our group has been looking for years at what fly-bys can do to other planetary systems, never considering that we ourselves might actually live right in such a system. The beauty of this model lies in its simplicity.*

*Our Sun was born from a collapsing cloud of gas and dust. In the process a flat disk was formed where not only large planets grew but also smaller objects like the asteroids, dwarf planets etc. Due to the flatness of the disk one would expect that the planets orbit in a single plane unless something dramatic happened afterwards. Looking at the solar system right to the orbit of Neptune everything seems fine: most planets move on fairly circular orbits and their orbital inclinations vary only slightly. However, beyond Neptune things become very messy. The biggest puzzle is the dwarf planet Sedna, which moves on an inclined, highly eccentric orbit and is so far outside, that it could not have been scattered by the planets there.*

*Just outside Neptune's orbit another strange thing happens. The cumulative mass of all the objects dramatically drops by almost three orders of magnitude. This happens at approximately the same distance where everything becomes messy. It might be coincidental, but such coincidences are rare in Nature.*

Susanne Pfalzner and her co-workers suggest that a star was approaching the Sun at an early stage, 'stealing' most of the outer material from the sun's protoplanetary disk and throwing what was left over into inclined and eccentric orbits. Performing thousands of computer simulations, they checked what would happen when a star passes very close by and perturbs the once-larger disk. It turned out that the best fit for today's outer solar systems comes from a perturbing star which had the same mass as the Sun or somewhat lighter and flew past at approximately three times the distance of Neptune.

These astronomers point out that, while nowadays, fly-bys of two stars in our region of the Milky Way galaxy are exceedingly rare, stars like our Sun are typically born in large groups of stars which are much more densely packed. Therefore, close fly-bys were significantly more common in the distant past. The team found that there was a 20 to 30 percent chance of experiencing a fly-by over the first billion years of the Sun's life. AK, with EarthSky and Wikipedia Notes



Artist's concept of a new solar system forming from a disk of gas and dust.