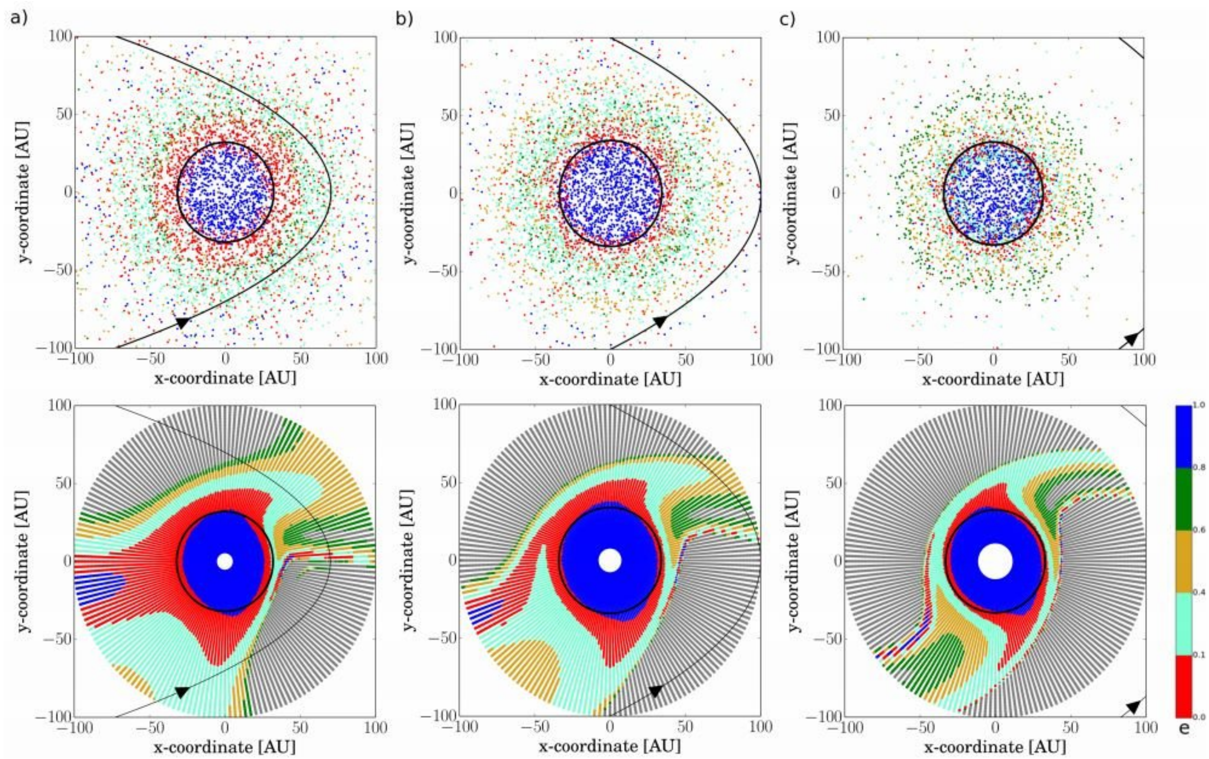
Did a rogue star change the makeup of our solar system?

July 20 2018, by Bob Yirka



Effect of a prograde, parabolic fly-by of a star with a) M=0.5 M , b) M2= 1, M and c) M2= 5 M that is inclined by 60 degree and has a angle of periastron equal zero. The perihelion distance is always chosen in such a way as to lead to a 30-35 AU disc. The top row indicates the eccentricity distribution of the matter with a central area of most particles on circular orbits and more eccentric orbits at larger distances form the Sun. The eccentricities are indicated by the different colours given in the bar. The origin of the different eccentricity populations in the original disc can be seen in bottom row, where matter indicated in grey becomes unbound from the Sun. Note that in c) the path of the perturber is not visible because it is outside the shown frame. Credit: arXiv:1807.02960 [astro-ph.GA]

A team of researchers from the Max-Planck Institute and Queen's University has used new information to test a theory that suggests a rogue star passed close enough to our solar system millions of years ago to change its configuration. The group has written a paper describing their ideas and have posted it on the *arXiv* preprint server.

In recent years, space scientists have begun to suspect that something out of the ordinary happened to our solar system during its early years. Many have begun to wonder why there is not as much material in the outer solar system as logic would suggest. Also, why is Neptune so much more massive than Uranus, which is closer to the sun? And why do so many of the smaller objects in the outer solar system have such oddly shaped orbits? In addressing such questions, many space scientists have begun to wonder if a star might have wandered by during the early years of the solar system—coming just close enough to pull some of the objects in the outer parts of the solar system from their prior positions.

The idea of a rogue star has been debated for some time, but the theory has not been embraced because of the timing—if a star had wandered by, it would have been approximately 10 million years after the birth of the solar system. But objects in the outer solar system would have still just been forming, making it unlikely that they would have been impacted by a rogue star.

In their paper, the researchers with this new effort suggest that recent research by other teams studying the formation of other solar systems has shown that the outer parts of such systems can be more developed than their inner parts. They suggest that if that were the case for our solar system, then it is possible that the outer parts had matured to the point where they could have been impacted by the gravitational pull of a passing star. To test their theory, they created a simulation of just such a scenario and found that it very closely matched what we are able to see today—a solar system with odd characteristics at its outer edges.

More information: Outer solar system possibly shaped by a stellar fly-by, arXiv:1807.02960 [astro-ph.GA] arxiv.org/abs/1807.02960

Abstract
The planets of our solar system formed from a gas-dust disk. However, there are some properties of the solar system that are peculiar in this context. First, the cumulative mass of all objects beyond Neptune (TNOs) is only a fraction of what one would expect. Second, unlike the planets themselves, the TNOs do not orbit on coplanar, circular orbits around the Sun, but move mostly on inclined, eccentric orbits and are distributed in a complex way. This implies that some process restructured the outer solar system after its formation. However, some of TNOs, referred to as Sednoids, move outside the zone of influence of the planets. Thus external forces must have played an important part in the restructuring of the outer solar system. The study presented here shows that a close fly-by of a neighbouring star can simultaneously lead to the observed lower mass density outside 30 AU and excite the TNOs onto eccentric, inclined orbits, including the family of Sednoids. In the past it was estimated that such close fly-bys are rare during the relevant development stage. However, our numerical simulations show that such a scenario is much more likely than previously anticipated. A fly-by also naturally explains the puzzling fact that Neptune has a higher mass than Uranus. Our simulations suggest that many additional Sednoids at high inclinations still await discovery, perhaps including bodies like the postulated planet X.