Astronomers detect a fast rotating group of stars in our galaxy

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Barred Spiral Milky Way. Illustration Credit: R. Hurt (SSC), JPL-Caltech, NASA

(Phys.org)—European astronomers have spotted a group of stars with high rotation velocity residing outside the solar radius in our Milky Way galaxy. According to a paper published Nov. 2 on *arXiv.org*, this group, which moves significantly faster than the majority of other stars, could provide essential information about stellar dynamics.

The discovery was made by a team of researchers led by Jason Hunt of the University College London, U.K. They have combed through the

Tycho-Gaia astrometric solution (TGAS) data included in data release 1 (DR1) from ESA's Gaia satellite. The spacecraft is completing a survey of one billion stars in our galaxy and local galactic neighborhood, measuring their positions with an accuracy of microarcseconds.

"We wanted to examine the speed with which the stars rotate around the Galaxy, and for that, we need velocity in three directions. We have never been able to explore local galactic dynamics in such detail because very few stars have had reliable distance estimates. This first data release provides distance estimates for around 2 million stars in the solar neighbourhood, and the next data release will have over one billion! This is a substantial improvement on the previous mission, Hipparcos, which provided measurements for about 150,000 stars," Hunt told Phys.org.

He noted that this fast rotating group of stars was difficult to pick out because Gaia DR1 only provides velocities in two directions across the sky, and not line-of-sight velocity toward and away from us. However, by looking directly toward or away from the galactic center, it was possible to approximate the rotation velocity.

The astronomers calculated that the newly detected group of stars is rotating faster than the sun by about 20 km s^{-1}. Moreover, they found that the stars in this fast rotating group are rotating significantly faster than the mean rotation of the stars.

Trying to explain these distinct velocities, the team assumed that they are caused by one of the two major spiral arms of the Milky Way - the Perseus Arm. The results indicate that stars which are behind the spiral arm, and at the pericenter of their orbits, experience an extended period of acceleration from the gravitational potential of the Perseus Arm.

"This extended period of acceleration causes them to move significantly faster than the other stars. We also know that this will either occur at one

point along the spiral arm if the arm moves as a wave with a constant pattern speed through the disc, or it will occur all along the arm if the spiral arm moves with the same velocity as the stars, which is predicted by computational models based on the gravitational interaction of stars, called N-body simulations," Hunt said.

The team's research supports both of the competing theories of spiral arm dynamics mentioned by Hunt. However, it favours slightly the theory seen in N-body simulations in which the arm moves with the same speed as the stars, because the scientists found that the feature remains unchanged at increasing distance from the sun.

"The quantity of data and the observational errors involved mean we cannot say for certain whether this is the case. We cannot observe further along the arm with the current data," Hunt noted.

The scientists hope that data shedding some new light on this case could be delivered by Gaia's data release 2 (DR2), scheduled to be published in November 2017. The increased quantity and quality of data in DR2 will allow the researchers to observe further along the spiral arm and determine whether this group is present along the entire spiral arm, or present towards the galactic anti-center.

"If it's present all along the arm it will be strong evidence for the type of transient reforming spiral arm created in the models, and if it is only present just outside the solar radius where we observed it in this work, it will be strong evidence for the theory that spiral arms travel as density waves through the disc," Hunt concluded.

More information: Fast rotating group of stars observed in Gaia TGAS: a signature driven by the Perseus arm? arXiv:1611.00761 [astro-ph.GA] arxiv.org/abs/1611.00761