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Possible confirmation of the spiral density-wave structure in the solar neighborhood using about 650000 Gaia EDR3 stars

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More than fifty years ago, Lin & Shu (1964), Lin & Shu (1966), Lin et al. (1969), and Shu (1970), published their basic, asymptotic theory of spiral sound-like density waves (or a breathing mode of collective oscillations'), developing in the disk of a rotationally flattened galaxy, by solving both gas-dynamic and Vlasov-Poisson equations for a 2D mass distribution. The theoretical concept of adensity-wave theory' was born, and was greatly refined in the coming years by the work of Bertin & Lau (1978), Lin & Lau (1979), Morozov (1980), and many others by considering the second-order effects.
Griv & Gedalin (2012) extended the theory by considering a 3D mass distribution. In this work, a sample of selected $\sim 500\,000$ stars from a total of 656\,161 sources of the system at distances $r < 3$ kpc from the Galactic Centre and $|z| < 300$ pc from the mid-plane identified in the {\it Gaia} EDR3 is leveraged. The parameters of solar peculiar motion and Galactic differential rotation corrected for the effects of small-amplitude 3D density waves, and the radial, transverse, and vertical components of streaming motion of stars due to the spiral arms as well as the geometrical and dynamical parameters of the waves are estimated from the measured line-of-sight velocities of objects. Two scales of periodic compression/rarefaction irregularity of the velocity field with the radial and vertical wavelengths of about 1.9 kpc in the form of a spiral density wave propagating in the disk are also revealed. We find that the velocity fields depart significantly from an axisymmetric model. These departures indicate the possible presence of local sound-like perturbations in the Galactic disk. We identify two features that are present in both planar and vertical velocities. These features appear to be associated with the Local and Scutum-Centaurus Spiral Arms.

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