Can we decipher the dynamics of the Milky Way spiral arms from Gaia ?

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The dynamics of the spiral arms of the Milky Way (MW) is a surprisingly old and unsolved problem. The unprecedented data from the Gaia mission has revealed a complex structure for the phase-space of the stars in the MW disk that is outstanding in the search for a complete dynamical model of the Galaxy. Here we concentrate on in-plane motions and on what they can teach us about the non-axisymmetric structures of the disk. In the joint presence of the Bar and Spiral Arms, it is particularly hard to analytically compute, through the linearized collisionless Boltzmann equation, the phase-space distribution function (DF) for the whole phase-space domain. However, the conservation of the DF in infinitesimal phase-space patches following the Hamiltonian flow allows us to compute the current DF by integrating orbits backward in time to an axisymmetric equilibrium state. In this way, we can construct a DF in the joint presence of the Bar and Spiral Arms, and confront the models to Gaia data with observables computed with the DF. We can therefore explore the space of parameters of the models to establish realistic dynamical non-axisymmetric models for the MW Disk and hopefully decipher the dynamics of the Galaxy's spiral arms.