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Applying Noether's Theorem to Matter in the Milky Way: Axisymmetry Tests with Gaia Data Release 2 Reveal External Perturbations and Non-Steady-State Effects AUSTIN HINKEL, SUSAN GARDNER, Univ of Kentucky, BRIAN YANNY, Fermilab — Gaia Data Release 2 reveals the local structure of the Galaxy in unprecedented detail. In this talk, we show how axisymmetry tests of the Galaxy can be realized, and consider how these tests confront common assumptions in galactic dynamics. Namely, we apply Noether's theorem, vis-a-vis tests of axisymmetry, to probe the quality of the angular momentum about the axis normal to the Galactic plane as an integral of motion. The failure of this symmetry would speak to a Milky Way that is not isolated and/or not in steady-state. The axisymmetry-breaking pattern we have found reveals both effects, with a typical asymmetry of 0.5%. We develop the selection of a data set suitable to such a study, avoiding regions with spiral arms and dust, and we evaluate the size of systematic effects with an estimated systematic asymmetry <0.1%. Finally, we present our recent results, highlighting how tests of axisymmetry can unearth various effects via their precise patterns of axisymmetry-breaking. For example, we note that a prolate form of the gravitational distortion of the Galaxy by the Magellanic Clouds, determined from Orphan stream fits by Erkal et al., 2019, is compatible with the axisymmetry-breaking we have discovered, suggesting a distortion of an emergent nature.

Austin Hinkel
Univ of Kentucky

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