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Dark Energy on Astrophysical Scales and Its Detection in Milky Way

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Understanding the origin and nature of dark energy is one of the greatest challenges of modern science. In this work, we investigate dark energy on astrophysical scales and provide a cosmology-independent method to measure its equation-of-state parameter w. First we introduce the concept of a perfect fluid in any static, curved spacetime and reexpress the energy-momentum tensor of the fluid in a general isotropic form, by which the equation-of-state parameter can be defined in a physical and global way. Within this theoretical framework, the energy-momentum tensor of dark energy on different scales can take the general isotropic form. In addition, we explore the SdS_w spacetime and establish its connection with dark energy in cosmology through the equation-of-state parameter. Locally a repulsive dark force can be induced by dark energy in the SdS_w spacetime. Then we apply the concept of the dark force to realistic astrophysical systems via the Poisson equation. Finally, we find that an anomaly in the Milky Way rotation curve can be interpreted by the dark force, and by fitting the galactic rotation curve, we model-independently obtain the value of the equation-of-state parameter of dark energy.

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