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On the dynamics of rotationally supported galaxies

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A recent finding, based on empirical data of 153 rotationally supported galaxies, with very different morphologies, masses, sizes, and gas fractions, revealed that the baryonic and the dark matter in galaxies are strongly coupled, such that, if the first is known, the second follows and vice versa. Here, we propose a completely theoretical analysis of the dynamics of rotationally supported galaxies, which results in the same conclusion. We find that the relationship between baryonic and dark matter densities at any radius r is governed by the law, ρ(r)_M + ρ(r)_DM = ρ_0, where ρ(r)_M, and ρ(r)_DM are, respectively, the densities of matter and dark matter at radius r, and ρ_0 is the density at the galaxy's center. Strikingly, we also found that the radius r_s, at which the rotation velocity is equal to half of its maximal value (or alternatively the radius r_c at which the baryonic matter density is equal to half of its density at the galaxy's center) constitutes a vivid signature of the galaxy, in the sense that it reveals rich information about the galaxy's dynamics, including the distribution of its matter and dark matter and their total amounts in the galaxy.

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