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A NEW FAMILY OF ANALYTICAL POTENTIAL-DENSITY PAIRS FOR GALAXY MODELS COMPOUND BY THIN DISKS AND SPHEROIDAL HALOS

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A new family of three-dimensional Newtonian models for galaxies is constructed. The models describe a thin disk and a matter halo, whose gravitational potentials satisfies the equation (2) presented in Gonzalez & Pimentel (2016, Phys. Rev. D, 93, 044034), and therefore, they satisfy the energy conditions for a gravitational system. The expressions for the potential of the disk and the halo are obtained by applying the "displace, cut, and reflect" method to the solution of the Laplace equation in cylindrical coordinates. Analytical expressions that describe the rotation curves and the mass distributions in the disk and in the halo are computed for the first three models of the family of solutions. It is shown that the mass densities of the disks and the haloes present a maximum at the center of the system and go to zero at infinity. Finally, for some values of the free parameters, the obtained rotation curves present a flat region for larger values of the radial coordinate.

The model was obtained considering the total gravitational potential, which satisfies the equation (2) imposed by Gonzalez & Pimentel (2016). The potential generated by the spheroidal halo of matter is constructed considering a multipolar expansion, expressed in cylindrical coordinates. As this solution of the Laplace equation a substitution is done so that the Laplacian is nonzero, the z coordinate (Kuzmin, 1956, AZh, 33; Toomre, 1963, ApJ, 138, 385). So the new potential satisfies Poisson equation and represents the distribution of three-dimensional material. From the gravitational potential analytical expressions were derived for the surface density of the disk, halo density of matter and from the rotation was derived. We found that the surface densities of the disks present a maximum at the center, vanishing at infinity; and the halo density is maximum at the disk surface, also vanishing at infinity. For some values of the parameters, the derived rotation curves present a flat region for larger values of the radial coordinate.

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THE LATE INTEGRATED SACHS-WOLFE EFFECT AND ITS DETECTABILITY IN GALAXY-REDSHIFT SURVEYS

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The late Integrated Sachs-Wolfe (ISW) effect is underwent by the Cosmic Microwave Background (CMB) photons due to the presence of the Large-Scale Structures (LSS) in an expanding Universe and can be measured through the temperature fluctuations of the CMB. In this work we use numerical simulations of structure formation to study the detectability of the ISW effect. Our method comprises the estimation of the density field through a Cloud-In-Cell mass assignment scheme. With the help of Fourier transforms we estimate the time derivative of the gravitational potential field in Fourier and in coordinate's space. Finally, this field is integrated numerically to know the ISW contribution. We study the time derivative of the potential in two approaches. First, an exact solution that makes use of the full velocity field. Second, a linear approximation related with the linear theory for the formation of LSS.

We apply the method to three cosmological simulations. First, a box of 400 h^{-1} Mpc; second, the MultiDark1[2] simulation; third, the MultiDark-Plank[3] simulation. For all cases we obtain coherent results with the expected in the literature for a ΛCDM cosmology: with the exact solution the temperature fluctuation is near the $\pm 30\ \mu$K; the linear approximation shows a signal in the expected range of $\pm 20\ \mu$K. This positive detection on simulations is important in order to know an expectation for the results we should obtain when working with observational data and will have important implications due to the lack of consensus about the detection of the ISW effect in previous works. Acknowledgements: This work was supported by Colciencias and Universidad de Antioquia, Convenio Beca-Pasantıa Joven Investigador Convocatoria 645 de 2014.

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[3] https://www.cosmosim.org/cms/simulations/mdpl/