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INFLUENCE OF HELIUM IN GRAVITATIONAL INSTABILITIES

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RESUMEN. Hemos analizado los modos hidrodinámicos de un modelo de fluido de dos componentes (hidrógeno y helio), y hemos obtenido la condición de inestabilidad para masas mayores que 1.39 veces la bien conocida masa de Jeans.

ABSTRACT, We have analysed the hydrodynamical modes of a two component fluid model (hydrogen and helium), and we have obtained the instability condition for masses greater than 1.39 times the well-known Jeans mass.

Key words: **COSMOLOGY – GRAVITATION – INSTABILITIES**

Generally, helium has not been considered as a material constituent of the cosmological models. We ieve, however, that this element could play a relevant role in gravitational instabilities and therefore in the origin of mological structures. In this sense we have idealized a hydrodynamical fluid composed of hydrogen and helium in Euclidean framework and analysed the hydrodynamical modes in order to find the instability conditions.

We assume a two component fluid model, without interactions, governed by the hydrodynamical ıations; namely the continuity equation, the momentum balance equation and the energy balance equation. ›reover in order to characterize the system completely we take into account the equation of state for each fluid ꟷ1 the Poisson equation (see Corona-Galindo et al. 1989). With the ansatz $A \sim A_0 exp(\omega t + i\bar{k}\cdot\bar{r})$ we solve the equations ımotion and obtain the following dispersion relation

$$\omega^4 + \left[(k^2 v_{s2}^2 - 4\pi G\rho_{02}) + (k^2 v_{s1}^2 - 4\pi G\rho_{01})\right]\omega^2 -$$

$$(4\pi G\rho_{02} k^2 v_{s1}^2 + 4\pi G\rho_{01} k^2 v_{s2}^2 - k^4 v_{s1}^2 v_{s2}^2) = 0, \quad (1)$$

ere the quantities with subindex (1), correspond to hydrogen and with subindex (2), to helium; v_{si}^2 are the sound ocities in each fluid and ρ_{0i} the unperturbed mass densities ($i = 1$ for hydrogen; $i = 2$ for helium).

find the instability condition we can either solve equation (1) numerically, or apply the Routh-Hurwitz criterion ›rona-Galindo 1985). According to the latter we obtain the instability for the following value of the wave-number

$$k^2 = 3.2\frac{\pi G}{v_{s1}^2}\rho_m, \quad (2)$$

ere ρ_m means the total matter density considering hydrogen and helium with a ratio of 4 to 1.

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Comparing the mass associated with the wave number given by equation (2), to that obtained by Weinbe (1972) we find for the Jeans mass of a hydrogen-helium fluid (M_{j2}) and that of a pure hydrogen fluid (M_{j1}) the followin relation

$$M_{j2} = 1.39 M_{j1}. \quad (\text{:}$$

Hence we conclude that the effect of helium is to increase the critical Jeans mass by a factor of 1.39.

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