RevMexAA (Serie de Conferencias), **49**, 112–112 (2017)

XV Latin American Regional IAU Meeting (Cartagena de Indias, Colombia, 3-7 October 2016)
Editors: Mario Armando Higuera Garzón & Santiago Vargas Domínguez

BARRED GALAXY FORMATION IN THE EAGLE COSMOLOGICAL SIMULATION

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RESUMEN

Utilizando la simulación hidrodinámica EAGLE, en el marco del modelo cosmológico ΛCDM, presentamos resultados acerca de la formación y evolución de barras estelares en galaxias similares a la Vía Láctea. En concordancia con resultados observacionales, esta simulación muestra que ∼ 40% de nuestras galaxias disco simuladas presentan barra con una amplia variedad de intensidades. Las longitudes típicas de las barras simuladas son ∼ 6.5 kpc, también acuerdo con valores observados. Nuestros discos sin barras son más ricos en gas y formadores de estrellas que aquellos que tienen barras intensas. En acuerdo con trabajos previos, las barras se desarrollan en galaxias donde el disco es gravitacionalmente dominante respecto al halo de materia oscura.

ABSTRACT

We present results about the formation and evolution of stellar bars in Milky-Way sized galaxies using the EAGLE ΛCDM cosmological hydrodynamical simulation. In agreement with observational results, this simulation shows that ∼ 40% of our simulated disk galaxies have a stellar bar with a wide variety of bar strengths. Typical bar lengths are $\sim 6.5 kpc$ also comparing favourably to observed ones. Our unbarred disks are more gas-rich and star-forming than those having a strong bar. In concordance with previous work, bars develop in galaxies where the disk is gravitationally dominant over the dark matter halo.

Key Words: galaxies: evolution — galaxies: formation

1. GENERAL

Bars are one of the most striking stellar components of spiral galaxies. Observational censuses indicate that more than 40 % of present day spiral galaxies have a central bar showing a wide variety of bar strenght.

The ΛCDM cosmological model is the actual paradigm for structure formation in the Universe. Given its success to reproduce statistical results about the large scale structure of the Universe one obvious question that emerges is its ability to reproduce , for example, the barred galaxy population. We address this question using the EAGLE (Schaye et al. 2015) cosmological simulation of galaxy formation. Our sample has 269 disk galaxies selected to have a stellar mass $10.6 < log(M_{str}/M_{\odot}) < 11$ clasified as: unbarred (∼60%), weak barred (∼20%) and strong barred (∼20%). This clasification is done using the maximum value of the second order m=2 Fourier mode $A_2^{max} = max(A_2(R))$ where R is the cylindrical radius (Athanassoula 2012). Disk galaxies with $0 < A_2^{max} < 0.2$ are clasified as unbarred, those with $0.2 < A_2^{max} < 0.4$ are clasified as weak barred and those with $0.4 < A_2^{max}$ are clasified as strong barred.

At redshift z=0, we have searched for correlations between bar strength parameter A_2^{max} and properties of the galaxies where they belong. Our analysis shows that bars are stronger in galaxies with smaller half-mass radius, have less gas and form the bulk of their present stellar population earlier.

The fact that stronger bars have a smaller half-mass radius; i.e. have more concentrated mass density profiles, seems to indicate that bars form in galaxies where the disk is more gravitationally dominant than the datk matter. This agrees with early seminal work of Ostriker & Peebles (1973) and Efsthatiou et al. (1982) showing that self-gravitating disks are unstable to barlike modes, while models with an aditional spherical halo are more stable.

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