Bayesian analysis for rotational curves with ℓ-boson stars as dark matter component

Atalia Navarro-Boullosa, Argelia Bernal-Bautista, J. Alberto Vázquez.

DCI-University of Guanajuato

ICF-Universidad Nacional Autónoma de México

INTRODUCTION

It has been shown that ultralight masses for a scalar field dark matter (SFDM), such as m~10^{-24} or 10^{-23} are tightly constrained by observations such as lyman-alpha [5]. The dark matter halos have been modeled as scalar field soliton and due to fast drop at small radii there is not good fit for the rotational curves. As an alternative approach we use a linear combination of l-boson stars as a dark matter componet.

OPEN

MODEL

The Schrödinger-Poisson system of equations is the non-relativistic limit of the EKG system, which is given by

$$E\psi_\ell = \left(-\frac{\hbar^2}{2m}\nabla^2 + \frac{\hbar^2}{2m}\frac{\ell(\ell+1)}{r^2} + mU\right)\psi_\ell$$

$$\nabla^2 U = \sum_{m=-\ell}^{\ell}(2\ell+1)4\pi G m^2 \psi_\ell^2$$

Where G is the gravitational constant, $\hbar$ is the plank constant, U is the potential and m the mass of the scalar field. The case with l=0 returns the solution for a simple boson star.

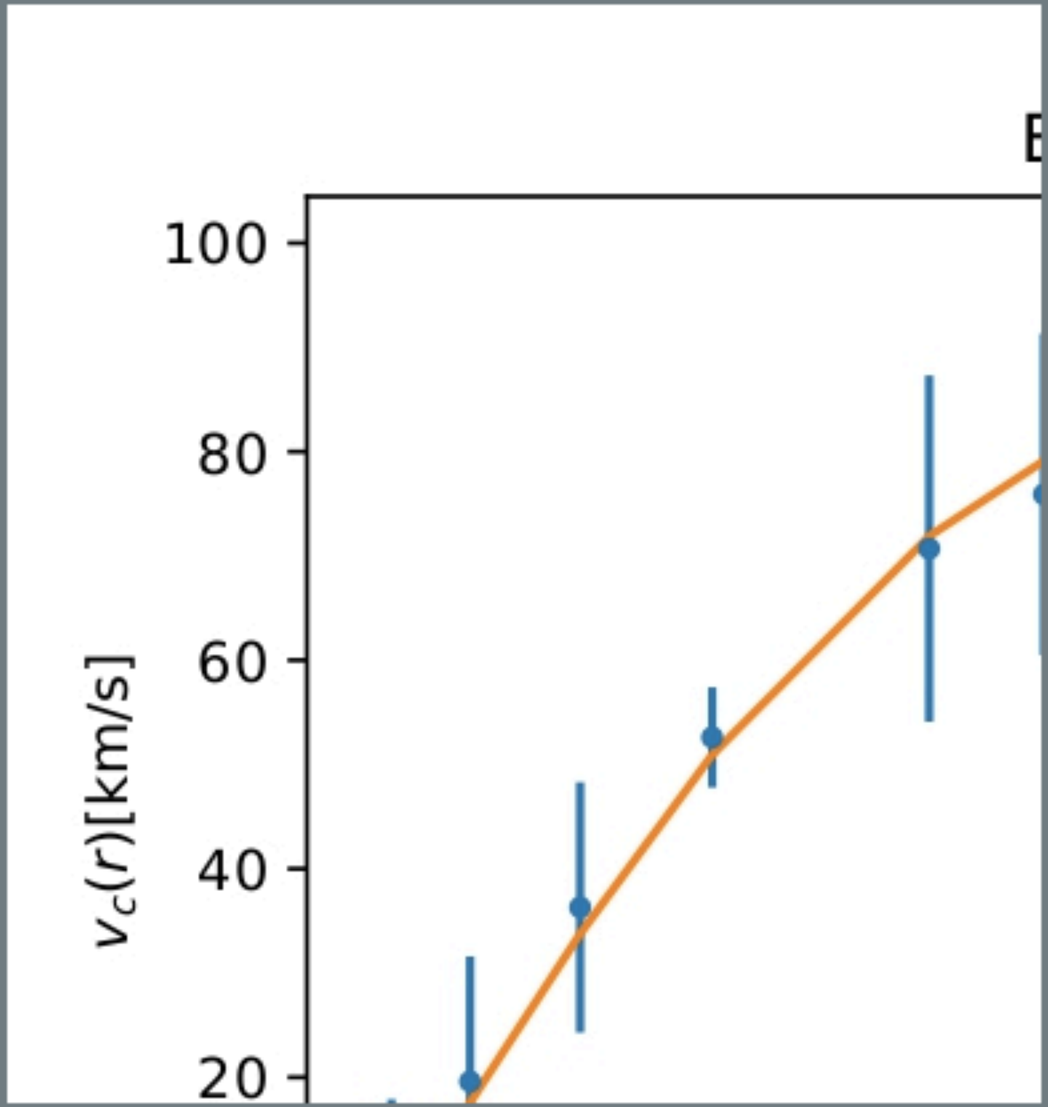
By using the following expressions

$$r = \frac{\hbar}{mc\epsilon}\bar{r} \rightarrow \nabla = \frac{mc\epsilon}{\hbar}\bar{\nabla}, V = \bar{V}\epsilon^2 c^2, \psi_\ell = \bar{\psi}_\ell \frac{c^2\epsilon^2}{\hbar\sqrt{4\pi G}}$$

OPEN

PRELIMINAR RESULTS

We present the results of the minimum χ^2 and the MCMC for the Low Brightness surface galaxy ESO3020120, which is include in the complete dataset used for this analysis. Where we take the linear combination of $\ell = 0 + \ell = 1 + \ell = 2$ and the solution for $\ell = 0$ to compare. Obtaing the following rotational curves



OPEN

METHOD

We use simpleMC a MCMC code for cosmological parameter estimation that allows us to easyly include any model.

We systematically add the solutions for each ℓ, we note a linear increase in the number of steps necessary for the convergence of the chains with respect to the number of parameters added for each ℓ

The free parameters are the mass of the scalar field (m_a) and ϵ for each ℓ being the former one, independently related with the amplitude of each ℓ.

NEXT STEPS

Use Bayesian evidence to discern between different linear combinations of ℓ and a base model

The preliminar results give us an insight of a better fitting with more that one state but how beneficial will it be to increase the states?

We are interested on see how this ℓ-boson stars linear superposition works for other types of galaxies and self-interaction.