Fermi Bubbles in Scalar Field Dark Matter halos

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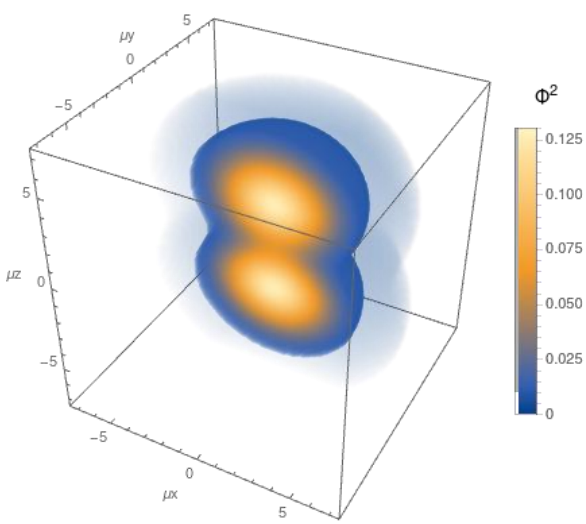
Quantum Mechanics can explain Dark Matter

In recent times, the Scalar Field Dark Matter (SFDM) model (also called Fuzzy, Wave, Ultralight dark matter model) has received much attention due to its success in describing dark matter on both cosmological and galactic scales. Several challenges of the Cold Dark Matter (CDM) model can be explained very easily and naturally by the SFDM model. Two of these challenges are to describe the anomalous trajectories of satellite galaxies called the Vast Polar Structure (VPOS) and to explain the Fermi Bubbles (FB) observed in our galaxy. In Phys.Rev.D103(2021)083535 an alternative explanation for VPOS was shown using the SFDM excited states, explaining the anomalous trajectories in a natural and simple way.

The Quantum Nature of the SFDM model implies that the DM density is similar to that of an atom



Three-dimensional density plot of the mass density $|\Phi|^2 = |\Phi_{100}|^2 + |\Phi_{210}|^2$ of the SFDM halo in the multi-state (Φ_{100}, Φ_{210}) configuration. In panel the total mass density is plotted.

This structure is able to explain the anomalous trajectories of satellite galaxies (VPOS). But also the observed FB (JCAP (2022) in press, arXiv:2203.13218), if

we assume that the SFDM particle is a Dark Photon. The inverse Compton scattering gives the result

$$\frac{dN_{tot}}{dtdE} \sim \frac{6.7 \times 10^{-4}}{\pi^2 E^2} \frac{1}{\mathrm{GeV\,cm^2}\, s^2\, sr}$$

In conclusion, because of the quantum character of SFDM, this is the only DM model that allows predicting a DM density profile with bubbles, as in atoms. With this axially symmetric shape of the profile, the SFDM model is able to explain not only the rotation curves in the galaxies but also the observed anomalous behavior of the satellite galaxies, the VPOS, in a very natural way. Now, we show that this DM profile can explain the FB observed in galaxies, provided that the SFDM has a milli-charge consistent with currents observational bounds. It is extremely interesting that the SFDM model can explain in such a natural way so many observable features of the galaxies and the cosmos, without further physical complications, even such unexpected observations as the VPOS or the FB. If this hypothesis is correct, we should see FBs in more large galaxies and gamma rays at higher energies in the near future.