# Structure formation in spin-s ULDM

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# What is ULDM?



 $\star$  The wave nature effects become relevant at galactic scales.

## What is ULDM?

 $\star$  Central regions of galaxies are made of **BECs**.



# Small-scale effects of the spin-0 field

★ Cut-off at small scales and interference patterns.



★ Spin-0 (FDM) ULDM naturally predict core halos.



# Why higher spin?

★ The field can have spin-0, 1 or 2.

Most studied case

★ Spin-0 is **highly constrained**.



★ Higher spin offers a richer (still unexplored) phenomenology.

# Why higher spin?

#### ★ Different interference patterns:

In larger component fields orthogonal components do not interfere.

#### **Higher spin**



★ Intrinsic spin: The final core is fractionally polarized.





# **Evolution of spin-s ULDM**



# The ground state solution for higher spin

The wave function can be decomposed as



Tensor

# **Simulation setup**



#### **Multiple soliton merger: Spin-0**



#### **Multiple soliton merger: Spin-1**



## **Multiple soliton merger: Spin-2**



#### **Comparison between models**



# Spin-s ULDM halos: Density profiles



## Spin-s ULDM halos: Spin





#### **Scaling relations for ULDM**





# **Construction of a DM profile**





#### **Dwarf spheroidal timing problem**

★ In CDM prescription:

The satellite remains orbiting

★ In FDM prescription





## **Equivalent DM profiles**

★ Characterise any DM profile as a function of N<sub>sol</sub>

$$\mu_{\rm eff} \equiv \frac{\rho_{c,0}^{\rm sat}}{\bar{\rho}_{\rm eff}}$$

$$\bar{\rho}_{\text{eff}} = \bar{\rho}_{\text{halo}}(r_{\text{sat}}) - \rho_{\text{halo}}(r_{\text{sat}})$$



# Survival time in a ULDM halo

Same  $\mu_{\rm eff}$  value

- ★ All models predict the same survival time.
- ★ It reproduces the same case as an uniform sphere.

★ 
$$μ_{eff}$$
~ T<sub>survival</sub>



#### Survival time in a ULDM halo





Higher spin give rise to less dense core structures



It could alleviate the problem in Veltmaat et al. (2020): Spin-0 + baryons lead to cuspy profiles (Core-cusp problem)

Spin-s ULDM model may predict longer dynamical times



It could relax the timing problem for dwarf spheroidal galaxiesgiving new constraints over the mass.

Comparison with observations!