

Diversity of the central dark matter densities in the Galactic dwarf spheroidals

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Thank you very much for supporting!



- Revisiting the core-cusp problem in the Galactic dwarf spheroidal galaxies Hayashi & Chiba 2020, ApJL, submitted
- The diversity of dark matter density profiles in the Galactic dwarf spheroidals Hayashi, Ishiyama & Chiba 2020, ApJ, to be submitted very soon
- Formation of massive globular clusters with dark matter and its implication on dark matter annihilation
 - Wirth, Bekki & Hayashi 2020, MNRAS Letters, to be submitted very soon
- J-factor estimation of Draco, Sculptor and Ursa Minor dwarf spheroidal galaxies with the member/foreground mixture model Horigome, Hayashi, Ibe et al. 2020, MNRAS, submitted
- Constraining dark matter annihilation with HSC Low Surface Brightness Galaxies Hashimoto, et al. (incl. KH) 2020, JCAP, 01, 059
- Non-sphericity of ultra-light axion dark matter halos in the Galactic dwarf spheroidal galaxies

Hayashi & Obata 2019, MNRAS, 491, 615

• The stellar halo of the Milky Way traced by blue horizontal-branch stars in the Subaru Hyper Suprime-Cam Survey

Fukushima, et al. (incl. **KH**) 2019, PASJ, 71, 72

 Effects of mass models on dynamical mass estimate: the case of ultra diffuse galaxy NGC1052-DF2

Hayashi & Inoue 2018, MNRAS Letters, 481, 59

• Dark halo structure in the Carina dwarf spheroidal galaxy: joint analysis of multiple stellar components

Hayashi, Fabrizio, Lokas, et al. 2018, MNRAS, 481, 250



The core-cusp problem in dwarf spheroidal galaxies

The core-cusp problem: the controversial issue on CDM theory





Moore 1994, de Blok 2000, Gilmore et al. 2007, Oh et al. 2015, Read et al. 2017

Core-cusp problem?



CORE OR CUSP?

CORE

A METHOD FOR MEASURING (SLOPES OF) THE MASS PROFILES OF DWARF SPHEROIDAL GALAXIES

Matthew G. Walker 1,2,3 & Jorge Peñarrubia^2

Dark matter cores and cusps: the case of multiple stellar populations in dwarf spheroidals

N. C. Amorisco* and N. W. Evans*

THE KINEMATIC STATUS AND MASS CONTENT OF THE SCULPTOR DWARF SPHEROIDAL GALAXY G. Battaglia,^{2,3} A. Helmi,³ E. Tolstoy,³ M. Irwin,⁴ V. Hill,⁵ and P. Jablonka⁶

THE DARK MATTER DENSITY PROFILE OF THE FORNAX DWARF John R. Jardel and Karl Gebhardt

The core size of the Fornax dwarf spheroidal

N. C. Amorisco,^{1,2} A. Agnello¹ and N. W. Evans^{1*}

Kinematics of Milky Way satellites in a Lambda cold dark matter universe

CUSP

Louis E. Strigari,^{1*} Carlos S. Frenk² and Simon D. M. White³

MEASURING DARK MATTER PROFILES NON-PARAMETRICALLY IN DWARF SPHEROIDALS: AN APPLICATION TO DRACO

JOHN R. JARDEL¹, KARL GEBHARDT¹, MAXIMILIAN FABRICIUS², NIV DRORY³, AND MICHAEL J. WILLIAMS²

On the Dark Matter profile in Sculptor: Breaking the β degeneracy with Virial Shape Parameters

Thomas Richardson^{*1}, Malcolm Fairbairn^{†1}

Dynamical models for the Sculptor dwarf spheroidal in a Λ CDM universe

Louis E. Strigari¹, Carlos S. Frenk² and Simon D. M. White³

The case for a cold dark matter cusp in Draco

J. I. Read^{1*}, M. G. Walker², P. Steger³

UNCLEAR

Model comparison of the dark matter profiles of Fornax, Sculptor, Carina and Sextans

Maarten A. Breddels and Amina Helmi

Orbit-based dynamical models of the Sculptor dSph galaxy

Maarten A. Breddels,^{1 \star} A. Helmi,¹ R. C. E. van den Bosch,² G. van de Ven² and G. Battaglia³

COMPLEXITY ON DWARF GALAXIES SCALE: A BIMODAL DISTRIBUTION FUNCTION IN SCULPTOR MAARTEN A. BREDDELS AND AMINA HELMI

> Cores in Classical Dwarf Spheroidal Galaxies? A Dispersion-Kurtosis Jeans Analysis Without Restricted Anisotropy

Thomas Richardson^{*1}, Malcolm Fairbairn^{†1}

A UNIVERSAL MASS PROFILE FOR DWARF SPHEROIDAL GALAXIES?*

MATTHEW G. WALKER¹, MARIO MATEO², EDWARD W. OLSZEWSKI³, JORGE PEÑARRUBIA¹, N. WYN EVANS¹, AND GERARD GILMORE¹

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1. Observed dSphs are **NOT** spherical shape



2. DM models predict **NON-spherical** DM halo



credit: Aquarius project







Non-spherical models















Hayashi & Chiba 2012, 2015b, Hayashi et al. 2016



Dark Matter profiles in the MW dSphs

Dark Matter Density Profiles of the biggest and smallest dSphs









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Hayashi & Chiba (2020, submitted)



What's the origin of the diversity?

What's the Origin of the diversity?



<u>CDM+baryon can explain the observed central DM</u> <u>density profiles in the classical dSphs.</u>

Future Prospects







- Revisit core/cusp problem using non-spherical mass modeling.
- There is no core-cusp problem in the classical dSphs, but the diversity of the DM inner slopes exists.
- The diversity could be explained by CDM+baryon physics, so far.
- For DM studies in the dSphs, deep and wide spec. survey by Subaru-PFS is absolutely needed.

Kohei Hayashi