Dark matter distribution 21/11/2015

• Program

- Motivation
- Objects of interest
- Simulations of dark matter halos
 - * Density profile and substructure
 - * Velocity distribution
- The standard halo model
- Uncertainties in the determination of the Milky Way halo parameters

• Literature

- L. E. Strigari, Galactic searches for dark matter, Phys. Rep. 531 (2013) 1
- Ed. by G. Bertone, Particle dark matter, Cambridge University Press (2010), chapter 2
- A. Helmi *et al., The merger that led to the formation of the Milky Way's inner stellar halo and thick disk,* Nature **563** (2018) 85
- J. Navarro, C. S. Frenk and S. White, *The Structure of Cold Dark Matter Halos*, Astrophys. J. 462 (1996) 563
- J. Diemand et al., Clumps and streams in the local dark matter distribution, Nature 454 (2008)
- M. Vogelsberger et al., Phase-space structure in the local dark matter distribution and its signature in direct detection experiments, Mon. Not. R. Astron. Soc. **395** (2009) 797
- J. Stadel et al., Quantifying the heart of darkness with GHALO a multi-billion particle simulation of our galactic halo, Mon. Not. Roy. Astron. Soc. **398** (2009) L21
- M. Vogelsberger et al., Introducing the Illustris Project: Simulating the coevolution of dark and visible matter in the Universe, Mon. Not. Roy. Astron. Soc. 444 (2014) 2, 1518 (2014), arXiv:1405.2921
- N. W. Evans et al., A travel guide to the dark matter annihilation signal, Phys. Rev. D 69 (2004) 123501
- A. M. Green, Astrophysical uncertainties on the local dark matter distribution and direct detection experiments, J. Phys. G44 (2017) 8, 084001 or arXiv:1703.10102

• Material for the lecture:



Figure 1: Anatomy of the Milky Way: an artist's impression of our Milky Way galaxy, a roughly 13 billon-year-old 'barred spiral galaxy' that is home to a few hundred billion stars. Figure from Left: NASA/JPL-Caltech; right: ESA; layout: ESA/ATG medialab.



Figure 2: Left: Comparison of different dark matter density profiles for the Galactic halo. Figure from A. Albert *et al.*, JCAP 10 (2014) 023 or arXiv:1406.3430. Right: Via Lactea II density profiles of main halo and subhaloes. Profile of a Milky Way-sized galaxy (black line) and eight large sub haloes (thin lines). Figure from J. Diemand *et al.*, Nature 454 (2008).



Figure 3: Via Lactea II projected dark matter density map of a galaxy with the mass of the Milky Way. Figures from J. Diemand *et al.*, Nature 454 (2008).



Figure 4: (Left) Velocity distributions for six haloes simulated with Aquarius in a 2 kpc box at a position similar to our Sun. v_1 , v_2 and v_3 are the velocity components parallel to the major, intermediate and minor axes of the velocity ellipsoid. (Right) Velocity modulus distribution for four simulated haloes at high resolution. All distributions are smooth and show characteristic broad bumps which are present in all boxes for a given halo. Figures from M. Vogelsberger *et al.*, Mon. Not. R. Astron. Soc. **395** (2009) 797.