DM & NP Working Group Overview

Elliott Bloom

02/28/06

SLAC

GLAST LAT Dark Matter and New Physics Working Group Activities Center on the Discovery Reach of GLAST in Addressing a Number of these Issues.

- **Particle Dark Matter (and Other Relics From the Big Bang)**
  - **SUSY**
  - **KK**
  - **…**
- **Other Searches for Extra Dimensions**
- **Violations of Lorentz Invariance**
- **The Search for Large Scale Matter - Antimatter Annihilations in the Universe (Why is There Only Matter in the Universe Now).**

Dark Matter and New Physics

Coordinators: Elliott Bloom Aldo Morselli

Members: 47 (Feb.06) (**39** Aug. 05)

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Ping Wang
Brian Winer
Marcus Ziegler

Group web page: http://www-glast.slac.stanford.edu/ScienceWorkingGroups/DarkMatter/
Wiki Page: https://confluence.slac.stanford.edu/display/SCIGRPS/Dark+Matter+and+New+Physics

Agenda
Tuesday, Feb 28: 5-8 PM

1. DM & NP Overview and Goals - Elliott Bloom,15 Min

2. Review of work in Europe - Aldo Morselli,15 Min

3. The search for Milky Way halo substructure WIMP annihilations using the GLAST LAT - Larry Wai, 15 min

4. The search for Milky Way halo substructure WIMP annihilations using the GLAST LAT (continued) - Ping Wang, 15 min

5. Benchmark points for DM study in view of DC2 preparation - Eric Nuss, 15 min

6. A quick look at recent papers, especially about dwarf spheroids - Johann Cohen Tanui

7. Detecting with GLAST gamma rays coming from LKP annihilations in the context of the minimal UED models - Andrea Lionetto, 15 min

7:00 PM. Bring in pizza and soft drinks for a working dinner. All share equally in cost.

8. Uncertainties in the interpretation of the diffuse galactic gamma-ray emission - Igor Moskalenko, 15 min

9. Wimp discussions with Wim - Igor Moskalenko, 15 min

10. Discussion

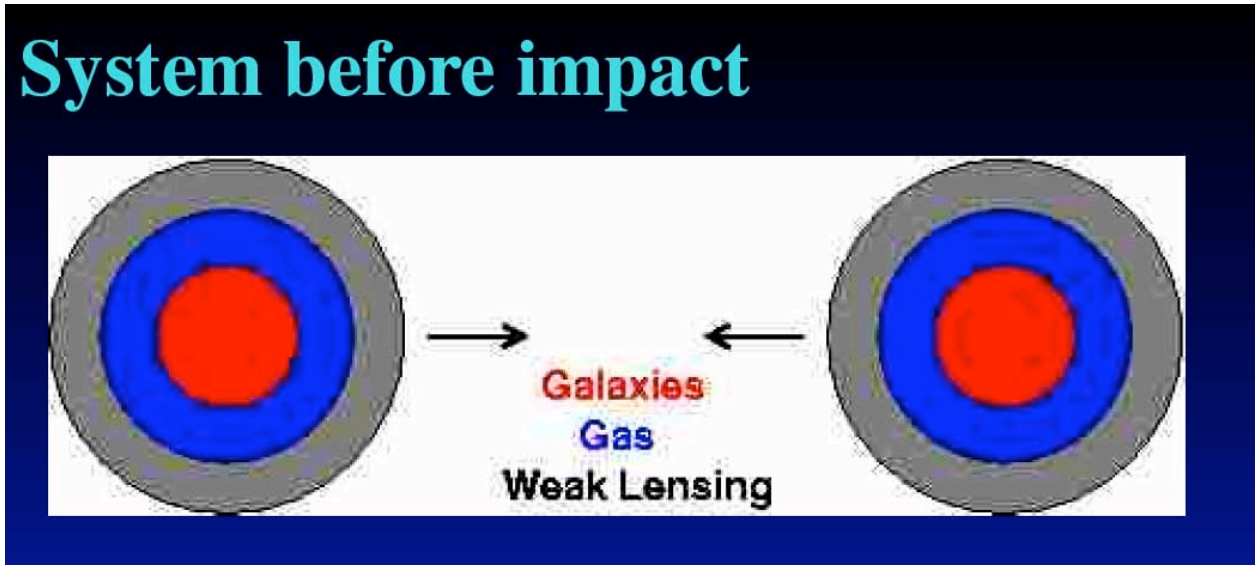
"Constraints on the existence and nature of dark matter from interacting clusters of galaxies"

Douglas Clowe (U Arizona)

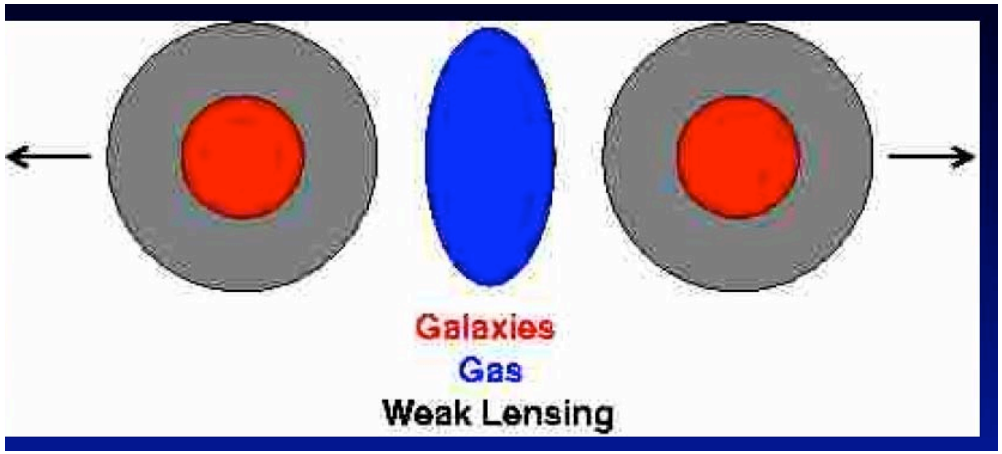
Talk at SLAC on Feb 3, and at UCLA DM Conference Last Week.

Since Zwicky (1937), we have known that clusters of galaxies have gravitational potentials which are too large to be explained by the amount of visible baryons under the assumption of a Newtonian gravitational force law. This has led to competing theories that either the masses of clusters are dominated by a non-baryonic form of matter or that gravity departs from a $1/r^2$ force law on cluster scales. By using merging clusters of galaxies (The Bullet Cluster in particular), I will show that the different types of matter in the clusters can be spatially separated and by using gravitational lensing I will prove, independent of any assumptions about the nature of gravity, that the dominant mass component of the clusters is not the visible baryons. I will also discuss how these observations can be used to place constraints on the nature of the dark matter, including a limitation on the self-interaction cross-section of any dark matter particles.

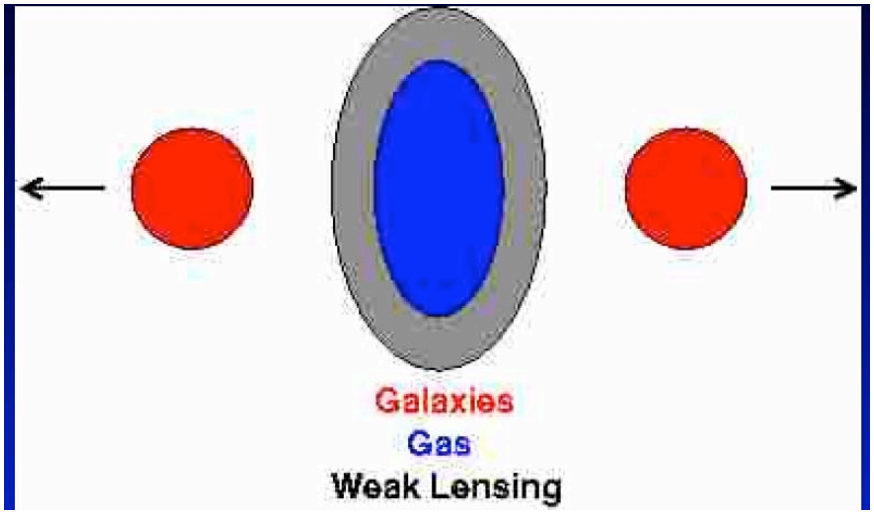
MOND is Wrong!



After Impact with DM



After Impact with MOND



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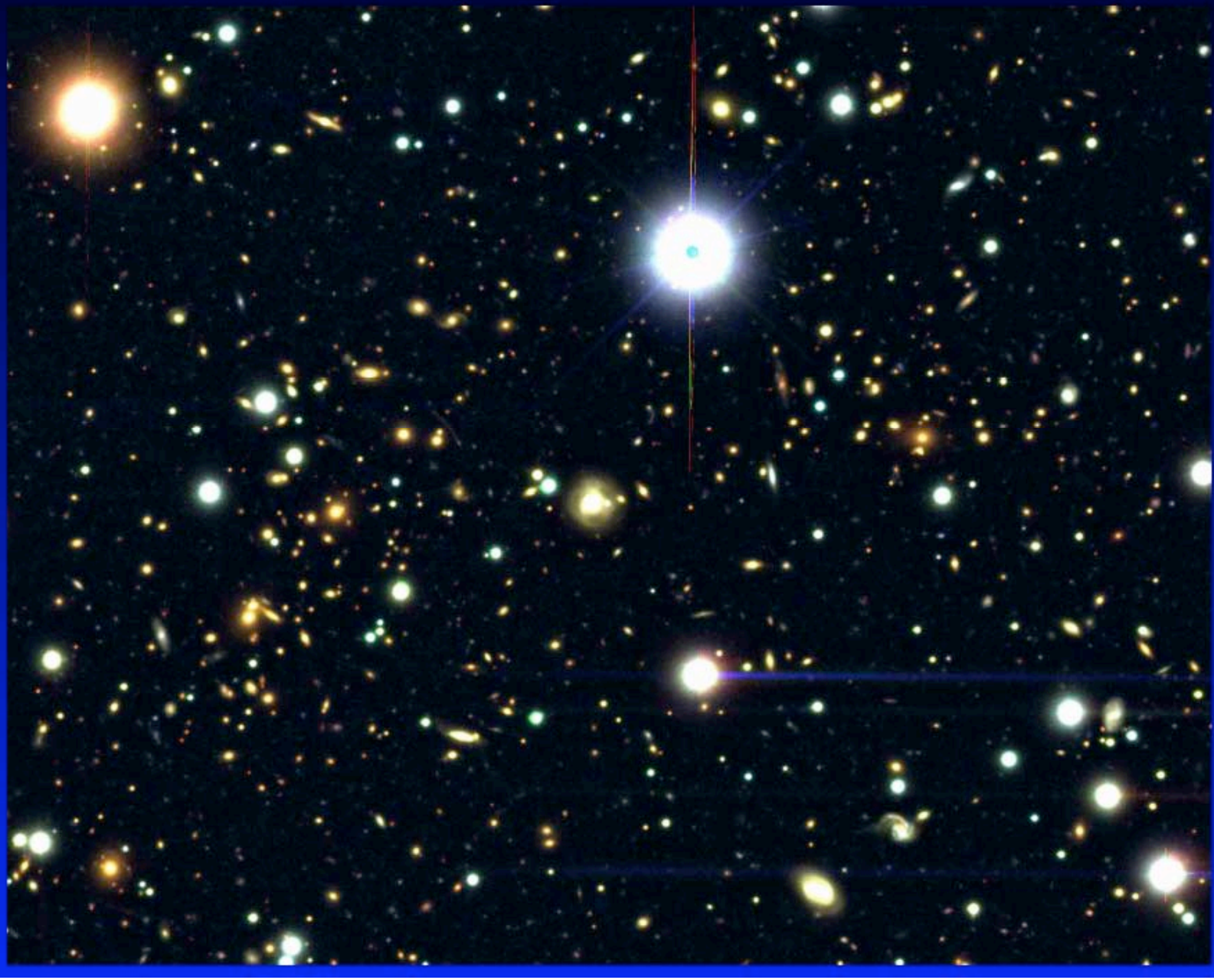
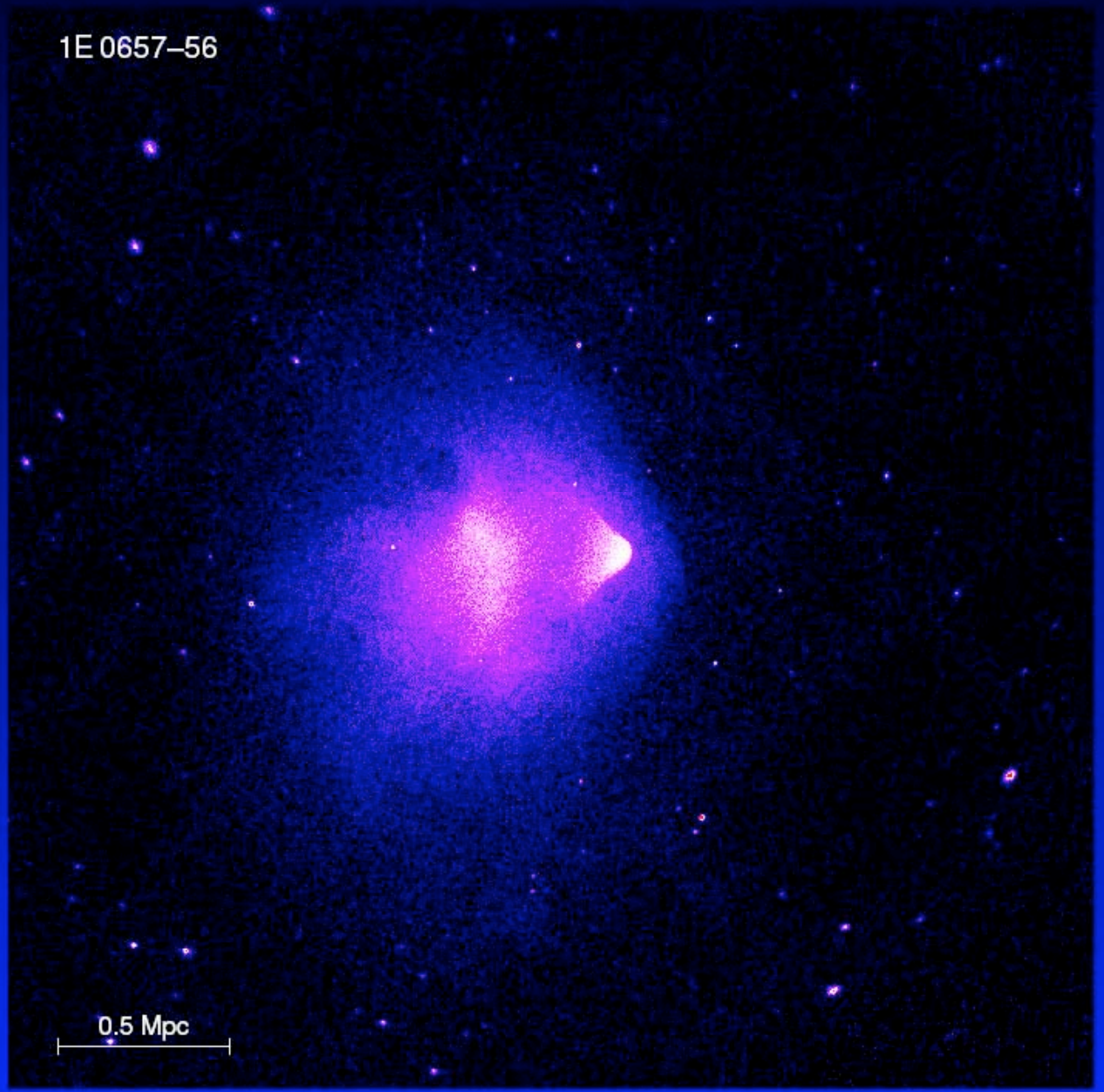
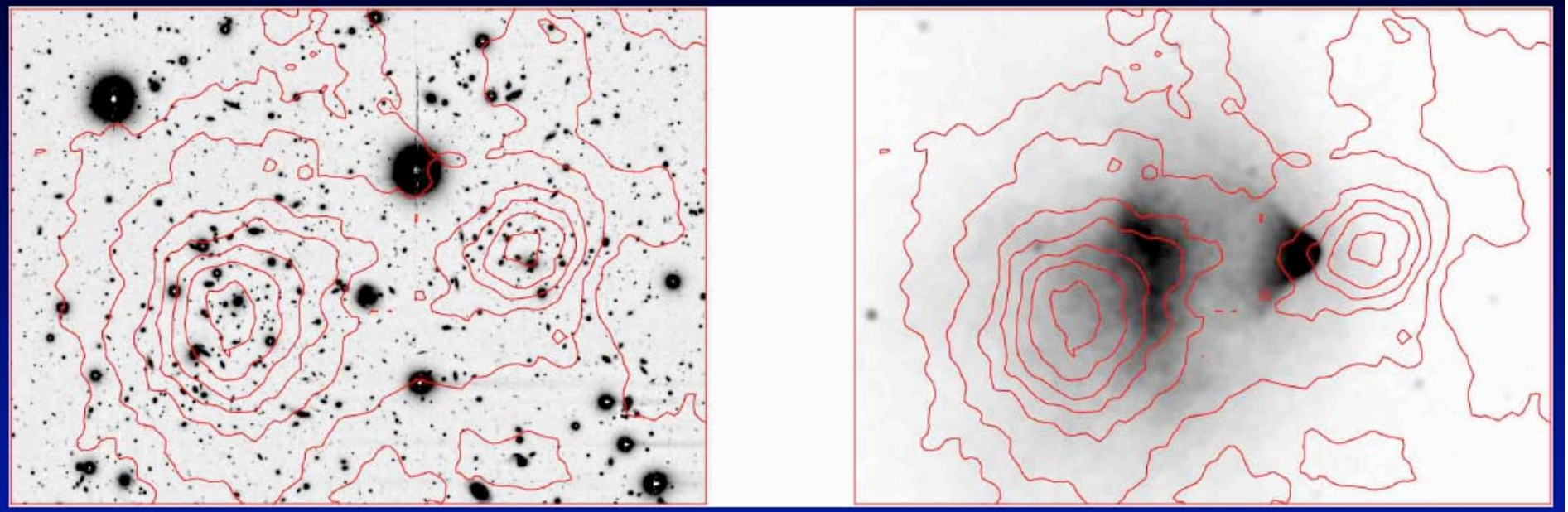


500 ks Chandra observation



Weak lensing reconstruction



DM, a moving target

Some observed properties of Dark Matter: a progress report on a dynamical study of the nearby dSph's

Gerry Gilmore
IoA Cambridge
Mark Wilkinson, Jan Kleyna, Wyn Evans,
Justin Read, Andreas Koch, Rosie Wyse, Mike Irwin, Eva Grebel,,
….
Data from: VLT, Keck, Gemini, WHT, INT, eso2.2…

The early context

- The ``standard'' value for local DM at the Sun is 0.3GeV/cc, all in a `halo' component
- (cf pdg.lbl.gov: Eidelman etal 2004)
- **the original work, and origin of this value, is the first analysis to include a full 3-D gravitational potential, parametric modelling, and a direct determination of both the relevant density scale length and kinematic (pressure) gradients from data, allowing full DF modelling for the first time:**

  Kuijken & Gilmore 1989 (MN 239 571, 605, 651), 1991 (ApJ 367 L9); 1989 Gilmore, Wyse & Kuijken (ARAA 27 555)
- **Cf Bienayme etal 2006 A&A 446 933 for a recent study**
- **Given the absence of a local enhancement, what is the smallest scale on which DM is detectable?**

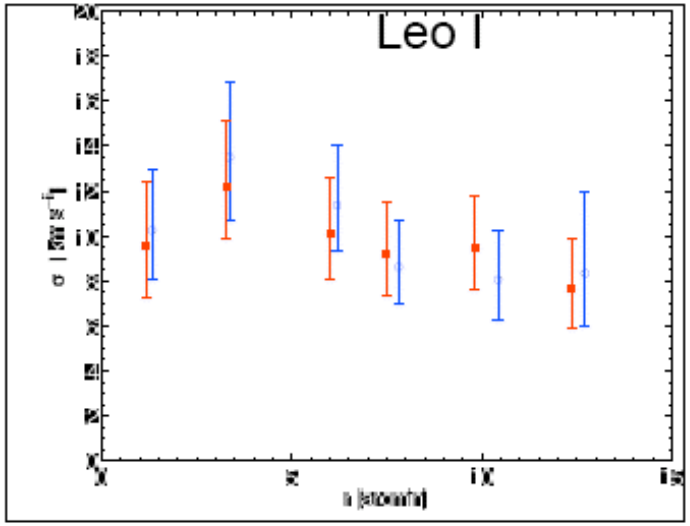
dSph satellite galaxies: what, why?

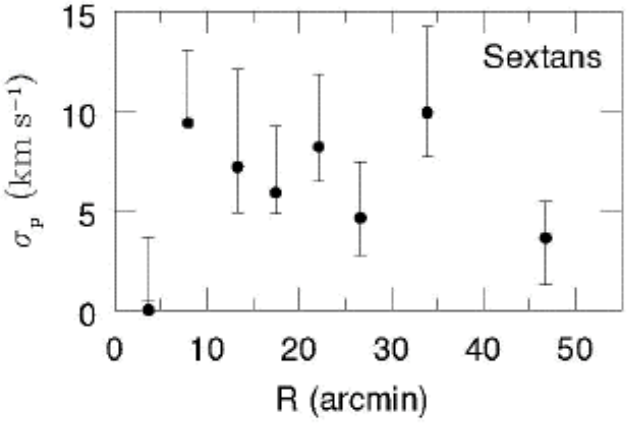
- Lowest stellar mass galaxies known
- In CDM test regime: eg famous sub-structure problem
- (ie, >1000 predicted, ~10 found)
- Have high M/L (Aaronson 1983) – 3 stars in Draco to deduce M/L=30 ➔ 1-D velocity dispersion high
- 1990 Pryor & Kormendy showed that extended dark halos were consistent with available data
- 1997 Mateo: first extended dispersion profile –Fornax
- 1998 Mateo noted M/L vs L may imply min DM mass.
- 2006: extended dispersion profiles available for Draco, UMi, Leo I, Leo II, Fornax, Scl, Carina, …1-D for UMa, AndII, AndIX with very many high-precision data – up to >500 stars/galaxy [Sext to come – complete sample]
- Kleyna etal 2000,2002,2003,2004, 2005, 2006;Tolstoy etal 2004, 2006; Munoz etal 2005; Walker etal 2005; Chapman etal 2005; Wilkinson etal 2004, 2006, Koch 06

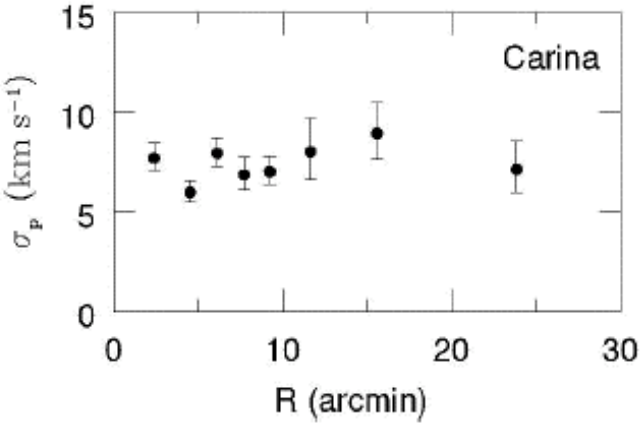
New data: UP TO 600 *s/GAL

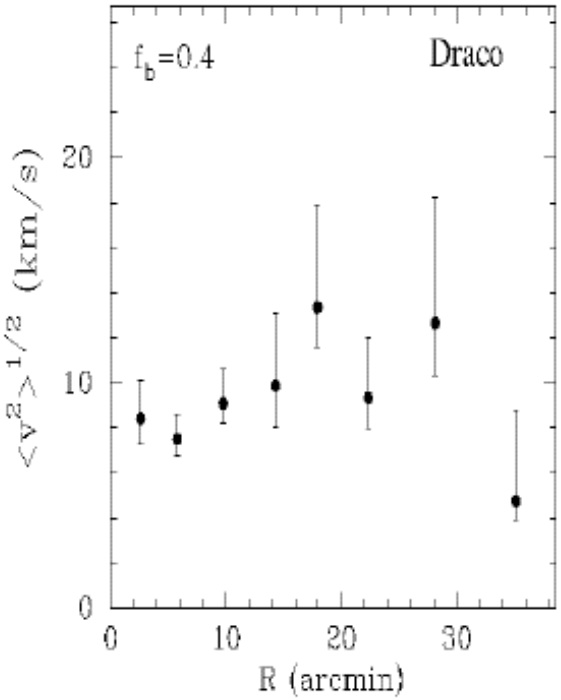
Note very low outer-most dispersions in Sextans, Draco, UMi: not yet understood

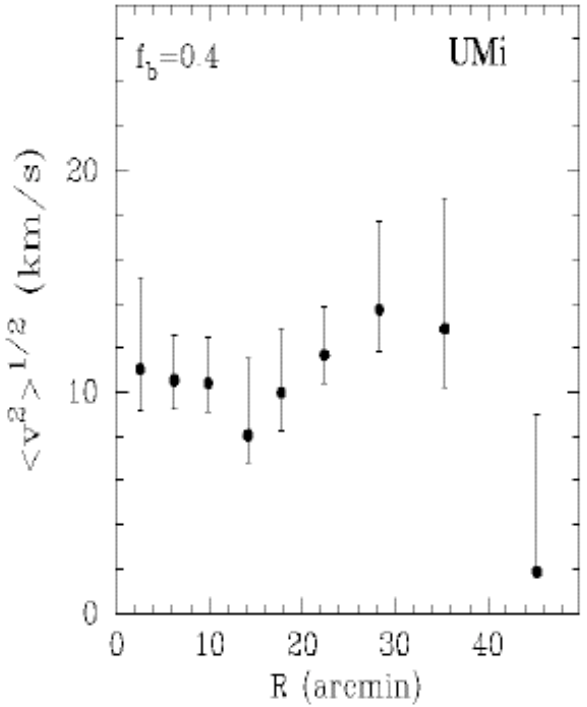
Expected dispersion if no DM: <1km/s









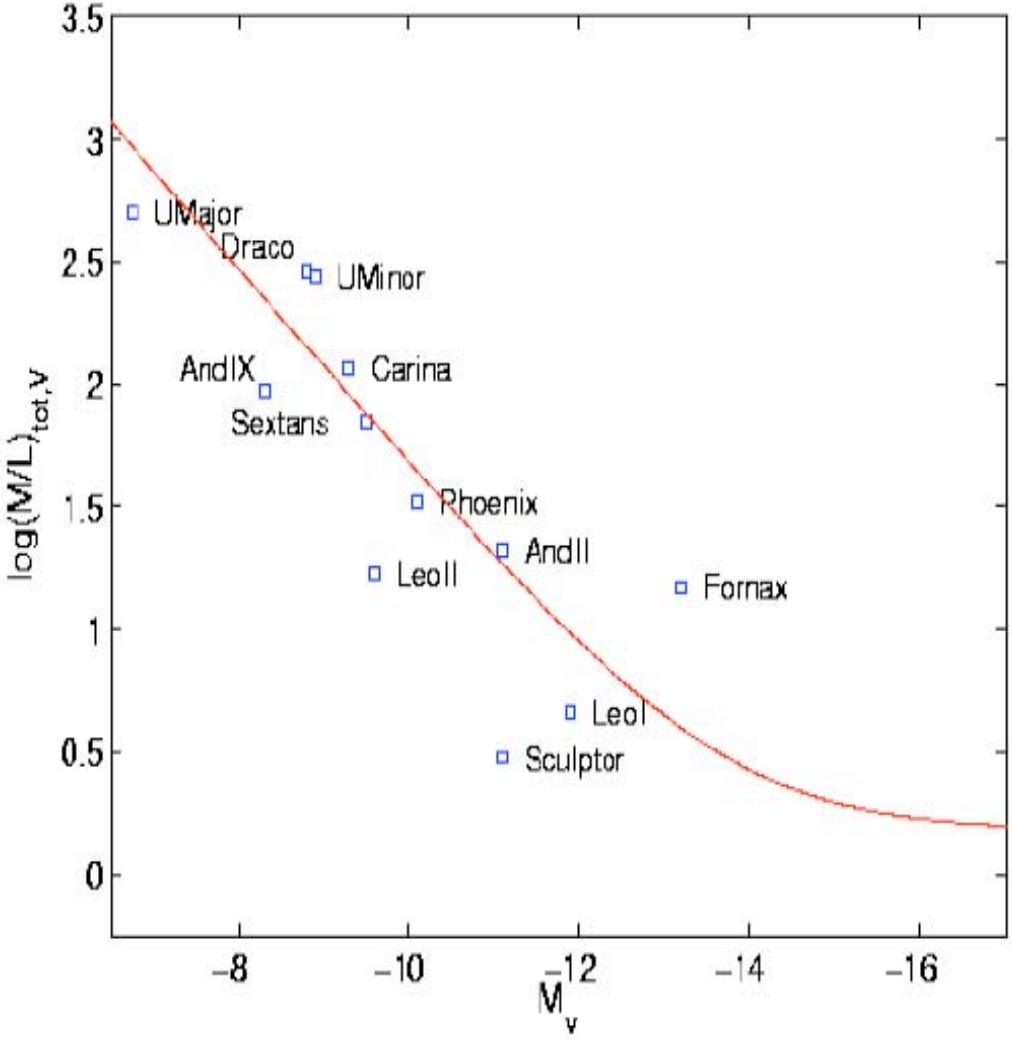


Systematic properties of DM –II

--minimum mass, scale, dispersion?

- Red line: constant mass DM halo,
- $M \sim 4 \times 10^7 M_\odot$
- apparent lower mass boundary
- Some data are old, central M/L only

Figure from astroph-0602186



summary

- A vast increase in precise stellar kinematic data allows more sophisticated derivation of mass profiles in the dSph.
- UMa – discovered 2005 – extends to M/L ~ 500
- All are consistent with:
- Central mass **cores**, not cusps
- Central mass density **≤20GeV/cc**
- Dispersion **~9km/s**
- Scale length **~few x100pc**
- DM minimum mass **~$5 \times 10^7 M_\odot$**