INSTITUTO DE ASTROFÍSICA
FACULTAD DE FÍSICA

Assembling the Largest, Most Distant Sample of Halo Wide Binaries for Galactic Structure and Dynamics

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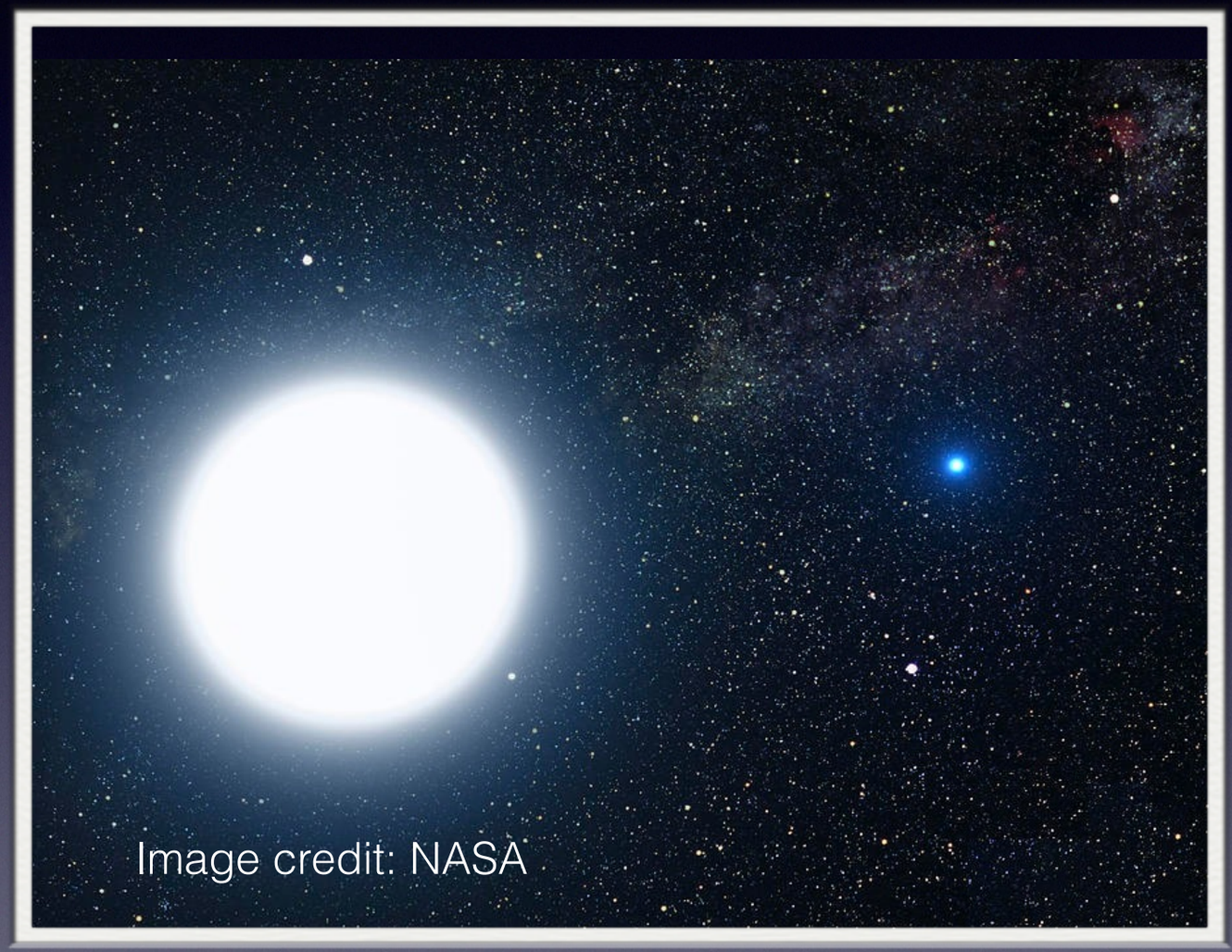
Image credit: Karen Teramura, UH Institute for Astronomy

Introduction

Why study binaries?
Why study wide binaries?

Existence of these objects, at separations greater than 0,1 pc (Quinn et al 2009, Chanamé & Gould 2004)

1. Their formation remains a mystery: star cluster environment?, isolated star formation?, dissolving clusters?
2. Susceptible to disruption of massive perturbers (constraints on the nature of dark matter (MACHOs))
3. They are like mini clusters



Astrometry on long timescales (or better instrumentation ie,GAIA)

An application to halo wide binaries

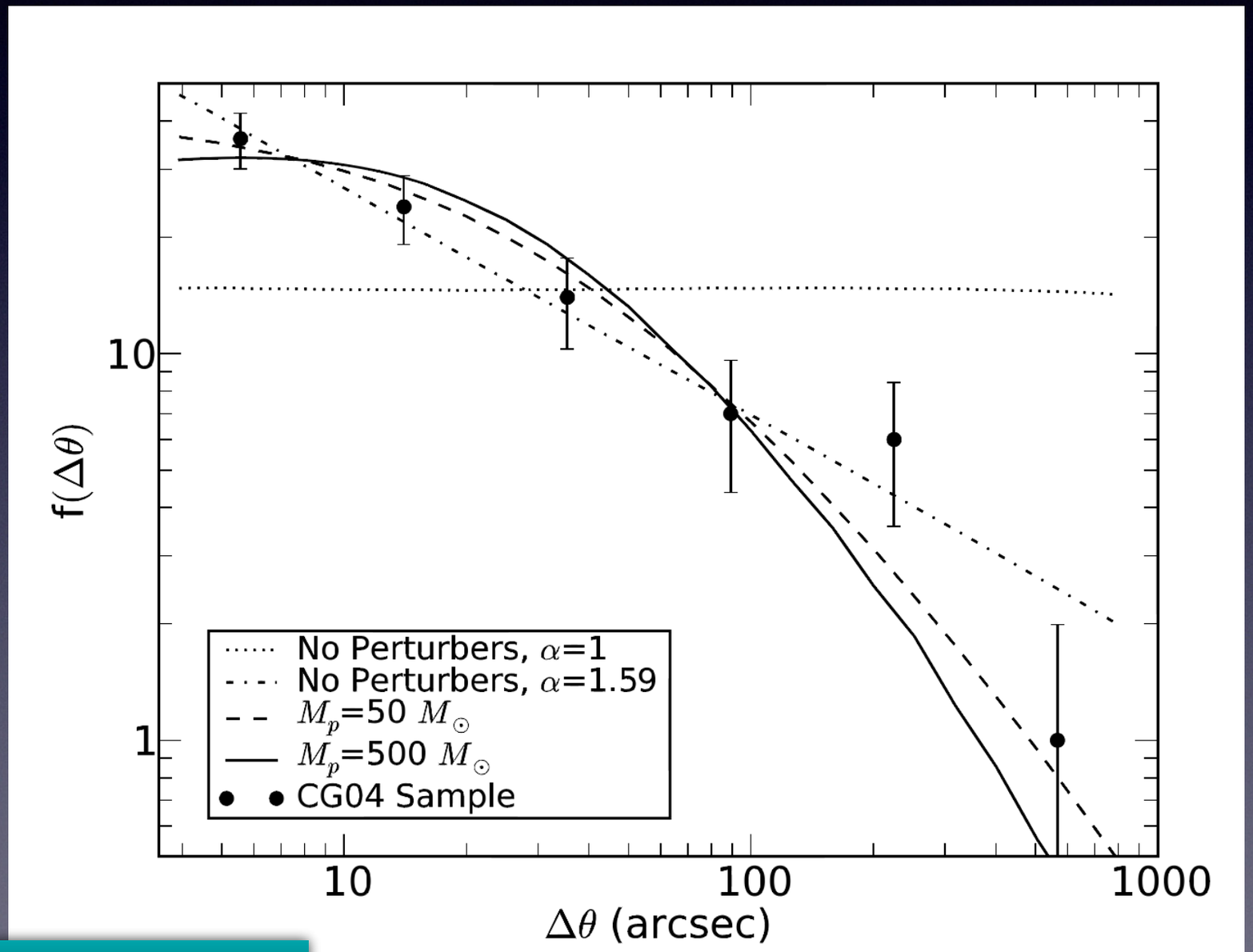
- Constraints on the mass of halo dark matter- excluding MACHOs of

$$M > 43\ M_{\odot}$$

Chanamé & Gould (2004)

- The result depends critically on the widest binaries of the sample (Quinn et al. 2009). Increasing the limit elminating a spurious pair

$$30\text{–}500\ M_{\odot}$$



Quinn et al. 2009

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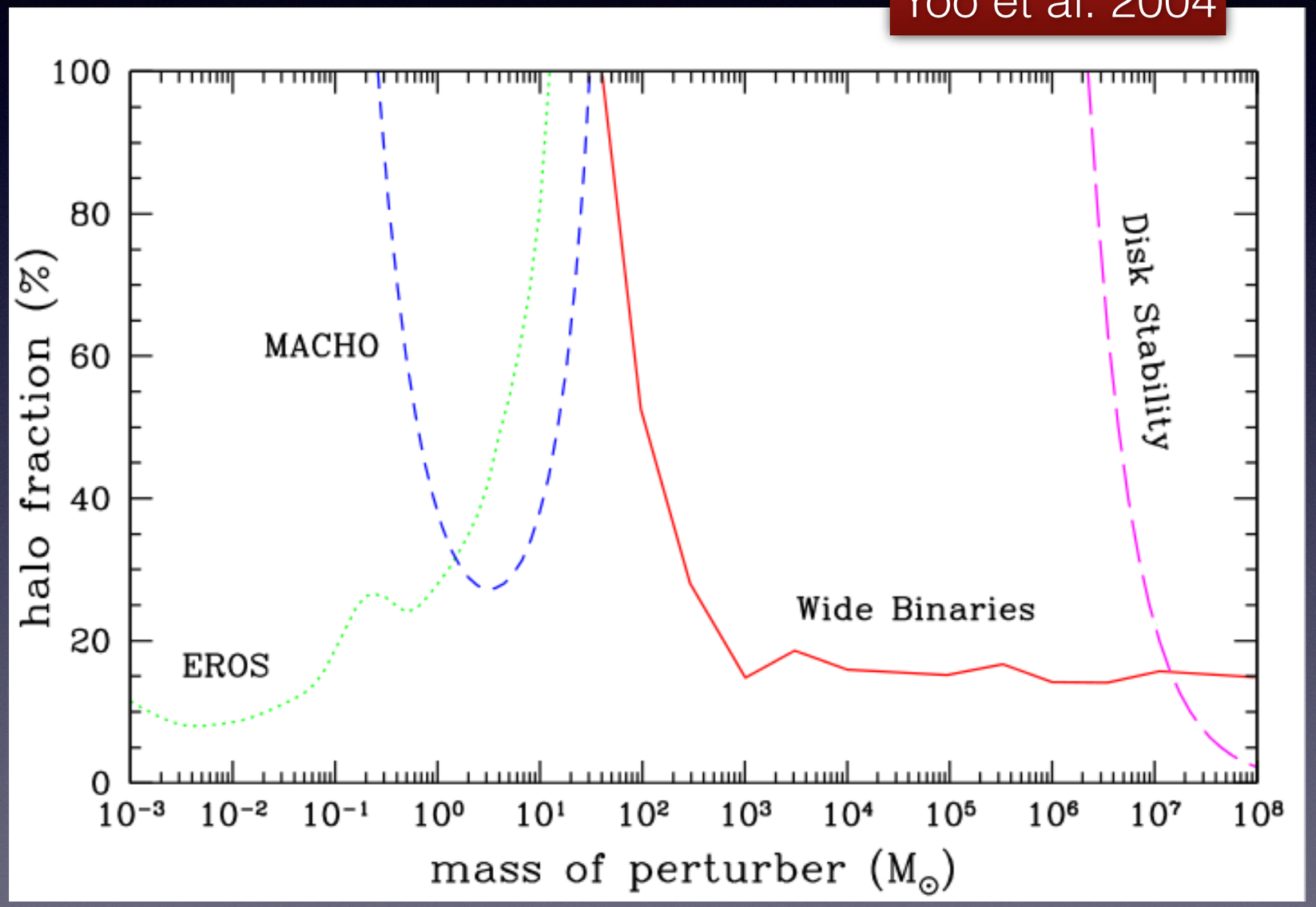
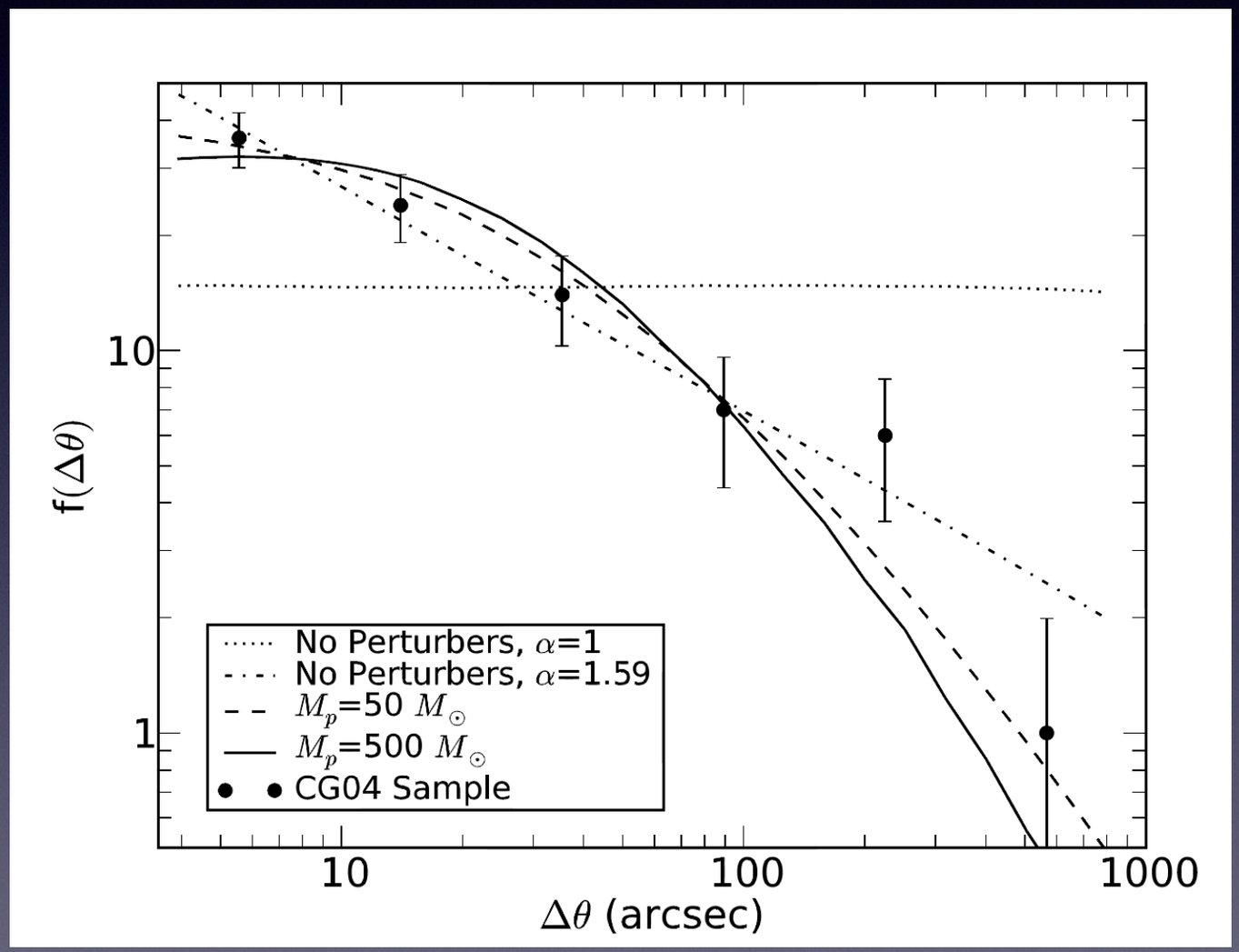
Yoo et al. 2004



We need to be sure that they are genuine binaries, how we do that?

Here comes the motivation

- The knowledge of halo wide binaries is still limited
- Dark matter studies depend on the angular distribution
- We need to increase the sample size of Wide Binaries to improve the understanding of these objects and quantify their implications on star formation and dark matter



Quinn et al. 2009

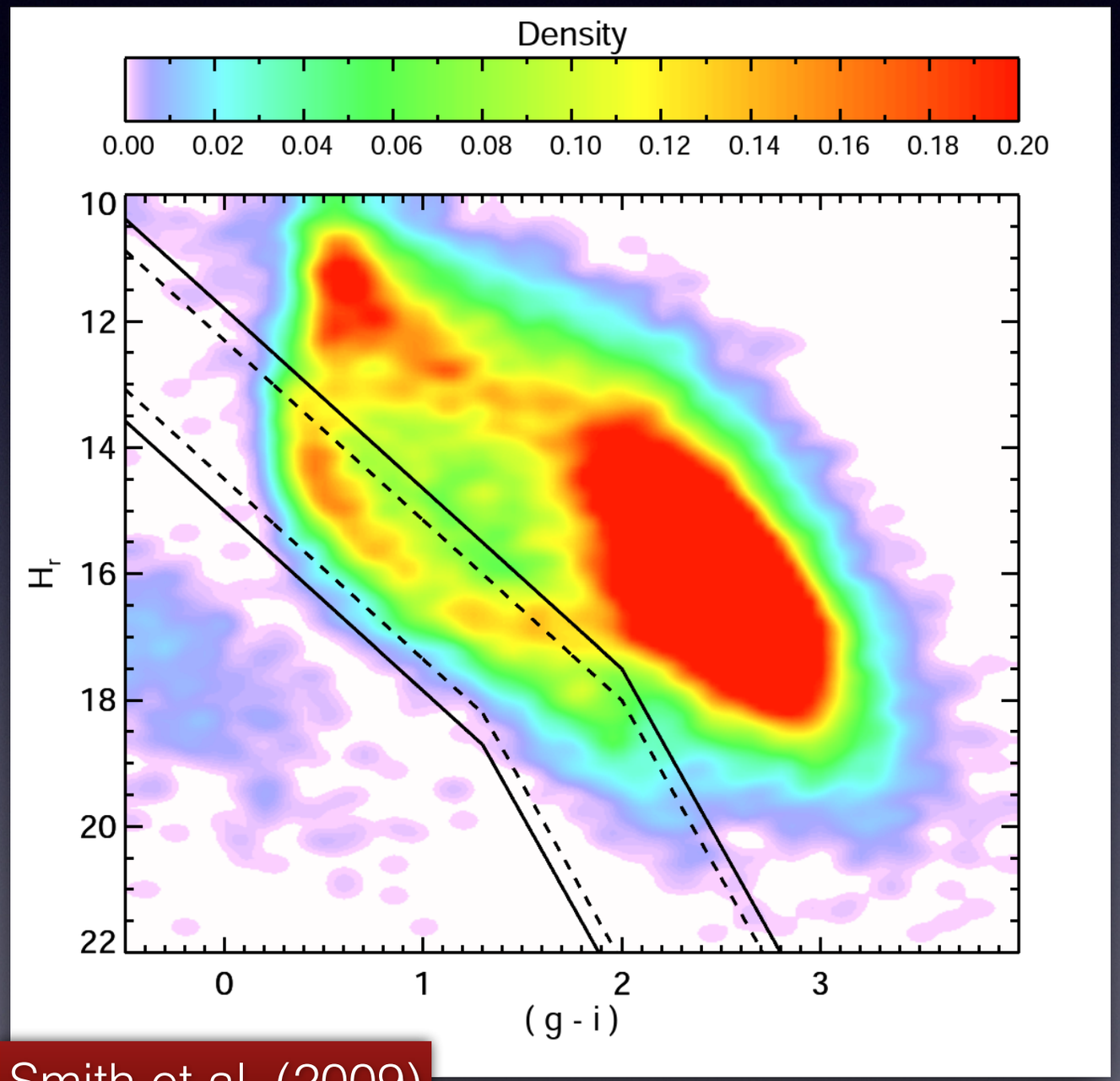
How to look for these objects?

- Common Proper Motion (CPM) method
- But this technique breaks down at larger separations...
- A motivation for undertaking a proper motion survey is to construct a Reduced Proper Motion (RPM) diagram

Reduced Proper Motion (RPM) Diagram

- The RPM uses proper motion and photometry information. Differences in metallicity and kinematics
- Roughly classify stars using the RPM even with no parallax or spectroscopic information
- Star's proper motion as a proxy for distance
- Disk and Halo stars have very different kinematics
- RPM in the r-band is given by:

$$H_r = r + 5\log\frac{\mu}{\text{mas yr}^{-1}} - 10$$



Smith et al. (2009)

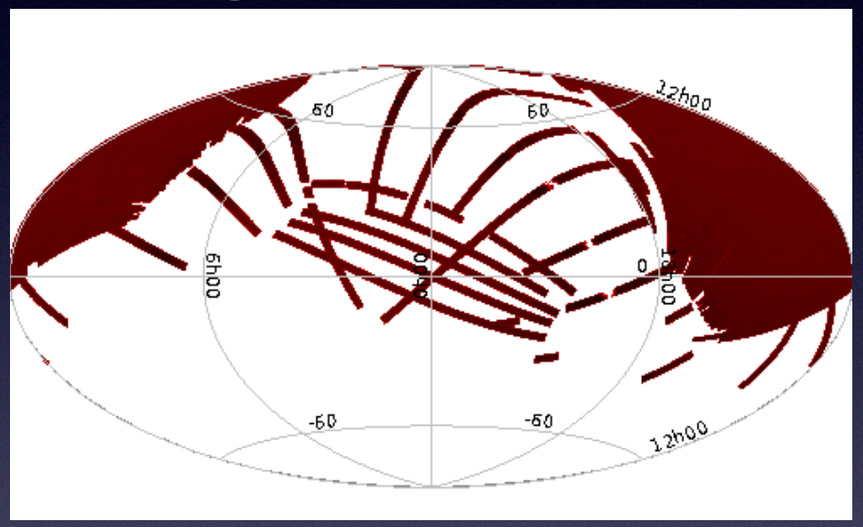
The purpose of this work

- We clearly need a larger sample of genuine halo wide binaries to better constrain dark matter.

Crucial point: Their value as dark matter probes depends on having no selection effects as a function of separation

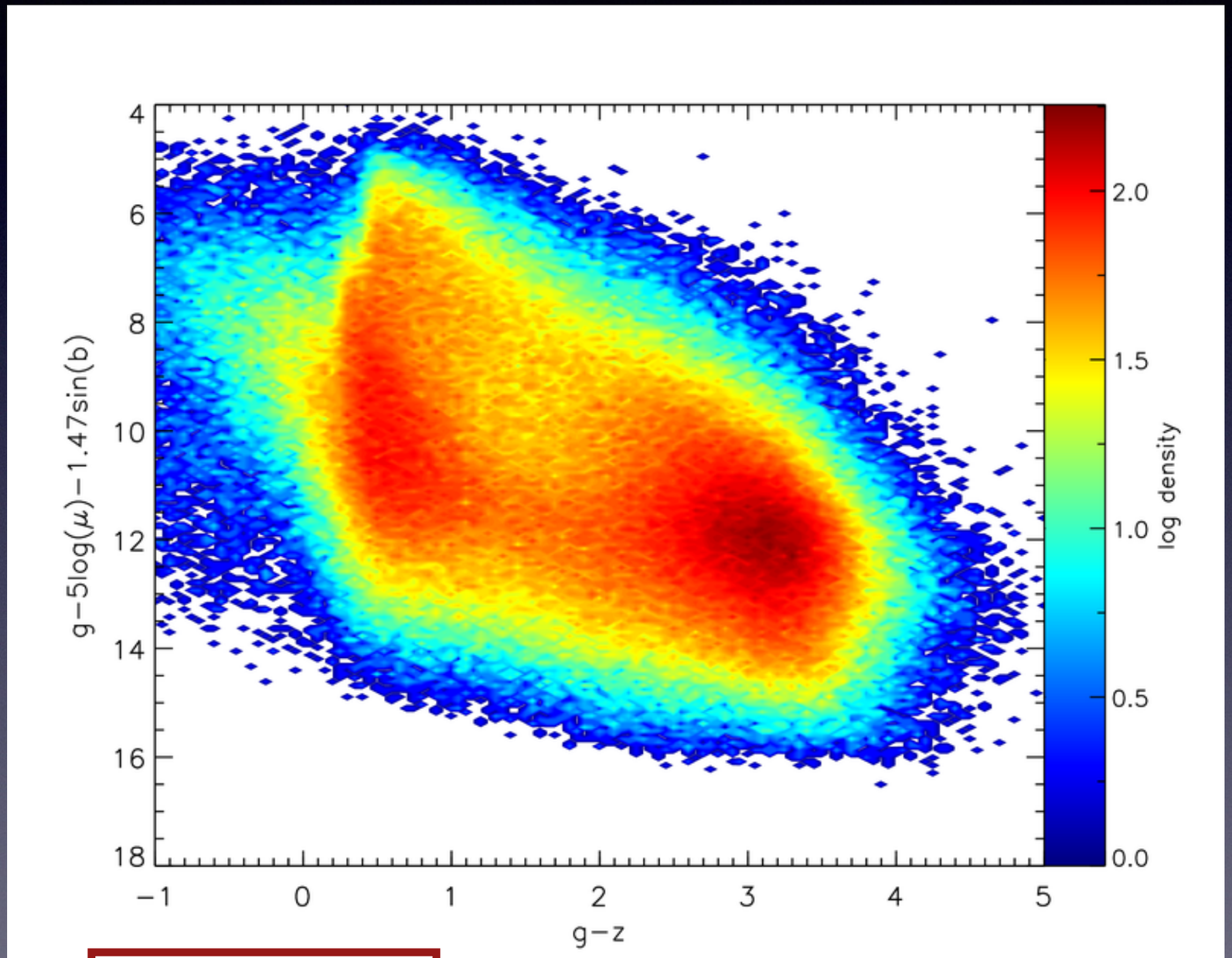
The challenge

- Selection of wide binary candidates using proper motions from SDSS (DR7)



- Distinguish the truly bound systems from among the number of false pairs in such a large sample with similiar proper motions
- 180 mas/yr vs 40 mas/yr
- For this task we need radial velocities

RPM for SDSS



$\mu > 40\,\mathrm{mas/yr}$

- The selection is done using constraints on

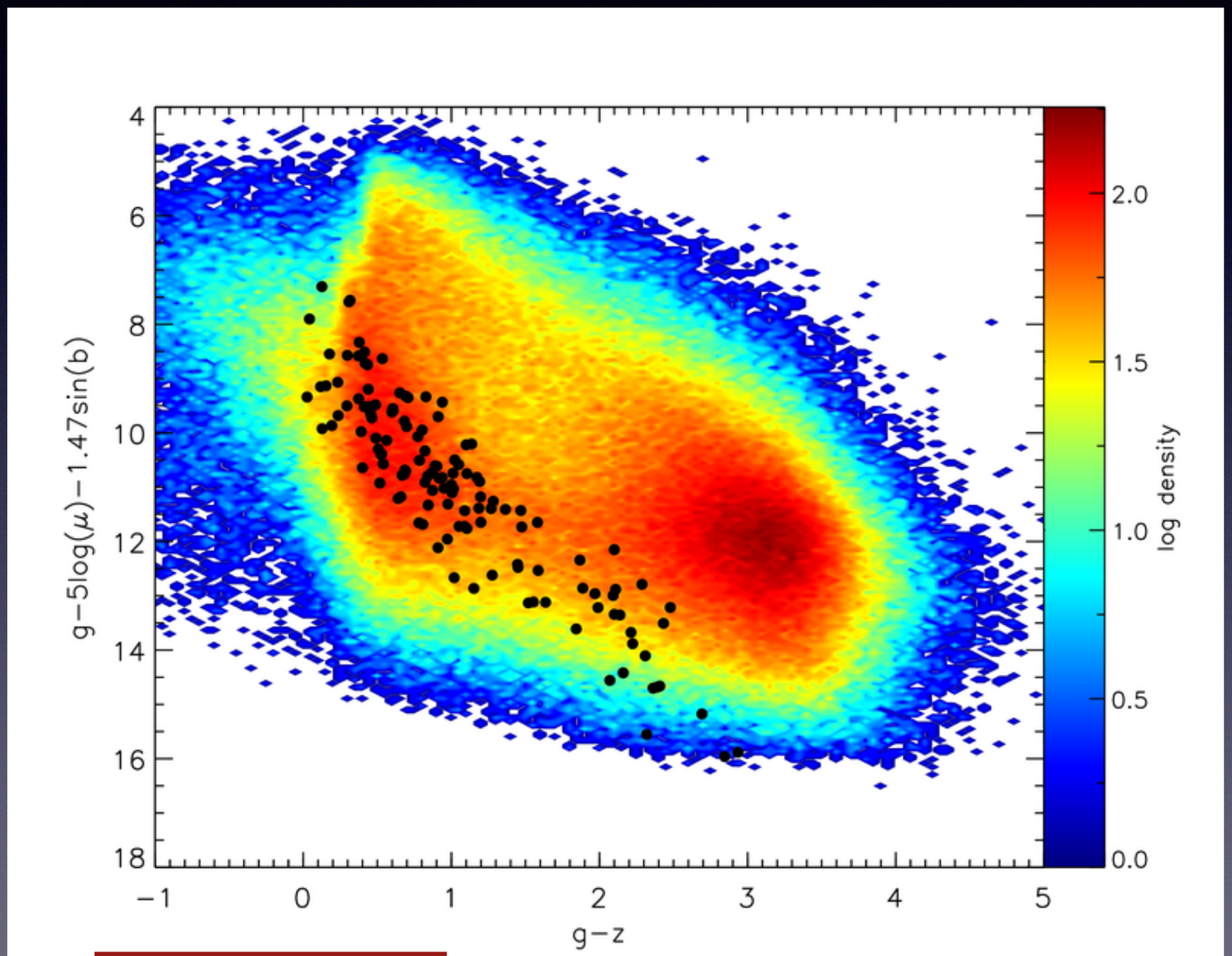
$$\mu > 40\,\mathrm{mas/yr}$$

$$10'' < \theta < 230''$$

$$\mu/\Delta\mu > 10$$

- We want to select stars belonging to the halo

RPM for SDSS



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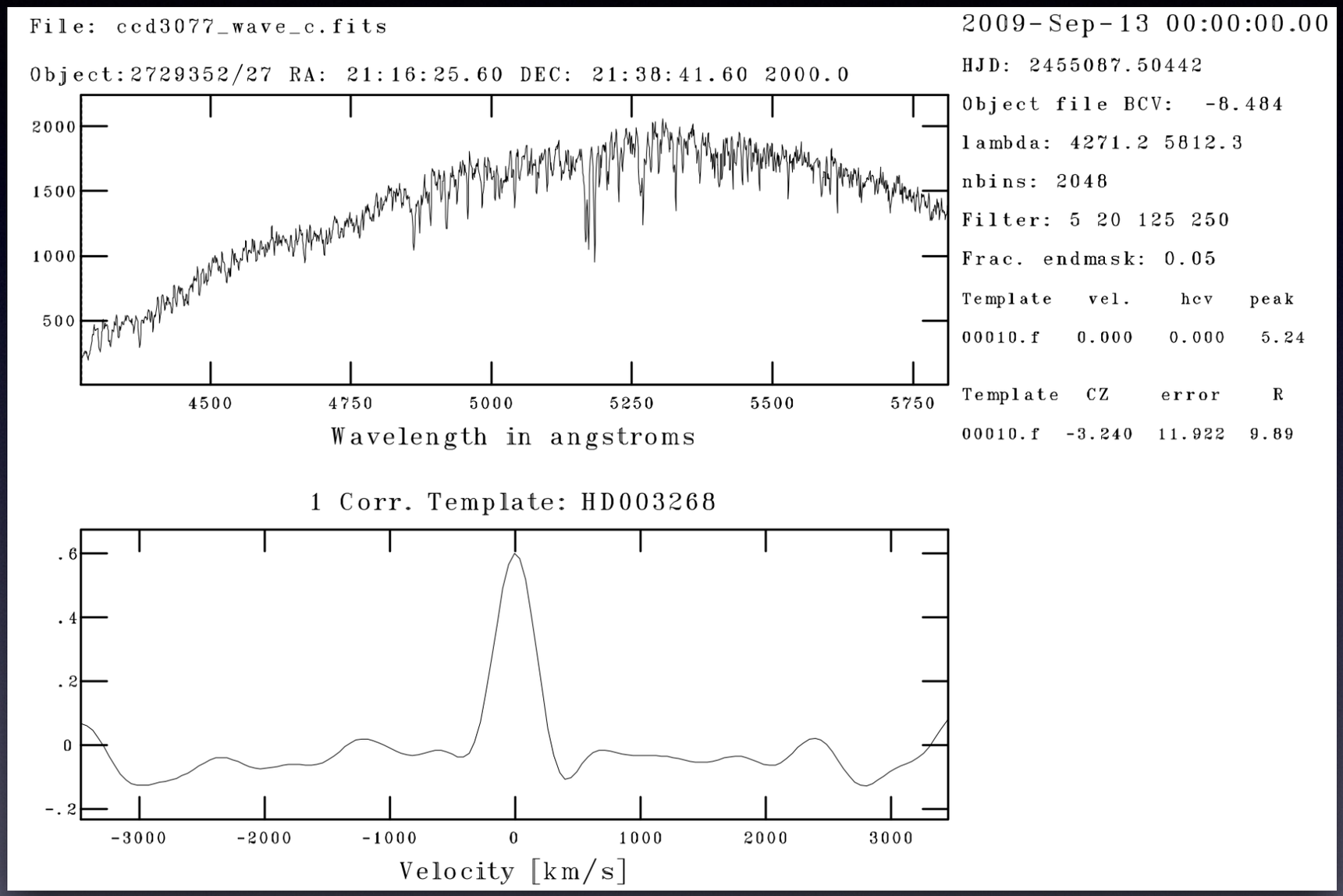
The selection

- Long slit spectra from B&C spectrograph in DuPont telescope for ~ 50 pairs (14<V<17)
- Echelle spectra from MagE in Clay telescope (for the faintest targets, 17<V<20)

Radial velocities

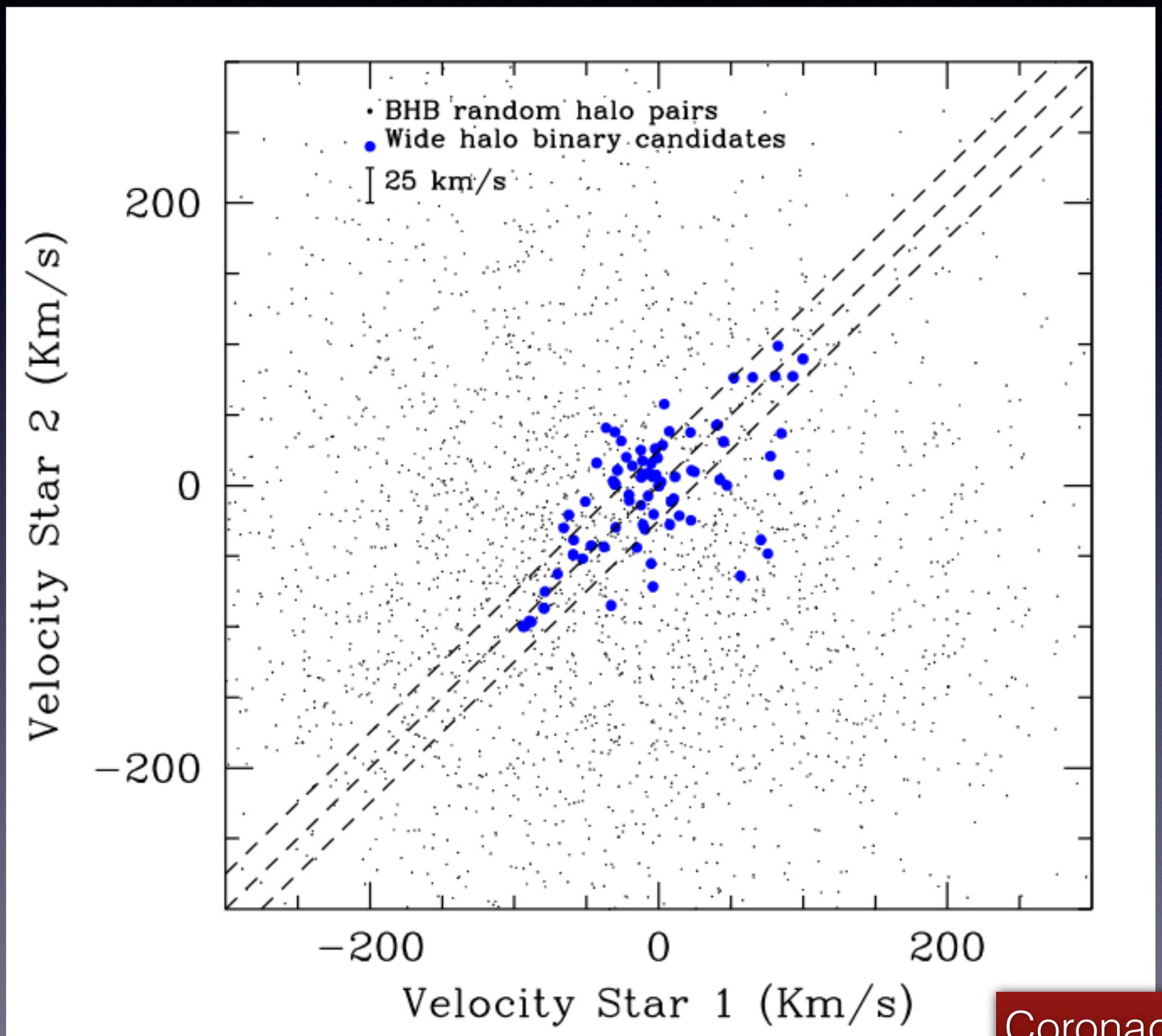


- Cross correlation using xcsao in IRAF with template spectra from ELODIE library
- Errors (Tonry & Davis 1979)

Error = 3w/8(1+r)

R: Reliability factor

Radial velocities



- Background from Xue et al. 2011 ~ 4000 stars (BHB) from the Milky Way Halo from SDSS DR8

Coronado & Chanamé (2015) in prep.

Final remarks

- Radial velocities for ~ 50 pre-selected pairs from our sample
- Our preliminary results are encouraging and show that the proper motion selection alone already selects many genuine wide binaries

Future work:

- Reduction and analysis of the remaining 50% from our sample with MagE
- Contamination analysis as a function of relevant parameters (total proper motion, angular separation, magnitudes)