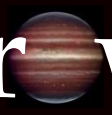
Kinematics and Luminosities of Br  wn Dwarfs with the BDNYC group

Adric Riedel

Gaia and the Unseen 2014.03.25

HUNTER The City University of New York

American Museum of Natural History

The City University of New York College of Staten Island

The BDNYC Question:

What can we learn about the internal properties of brown dwarfs from their spectra?

How well can we know it?

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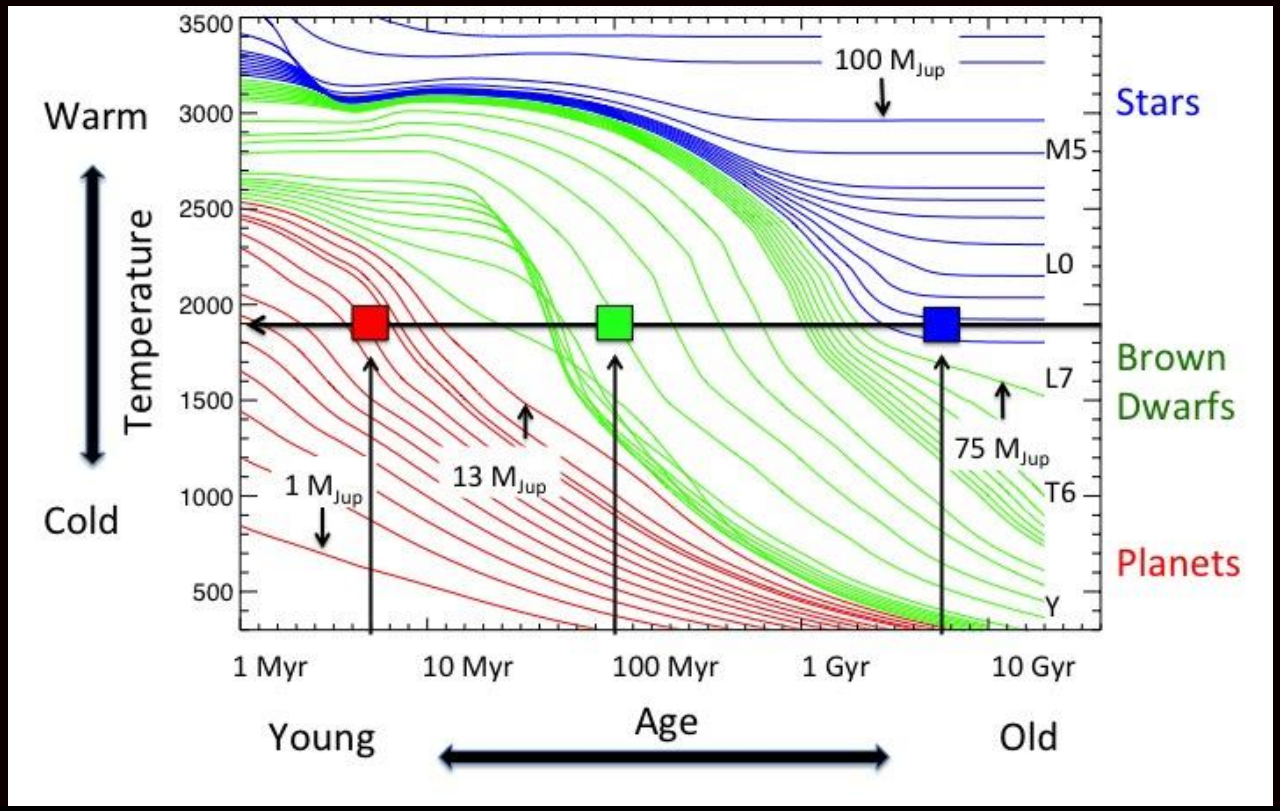
Our understanding of brown dwarfs depends on their ages



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Introduction

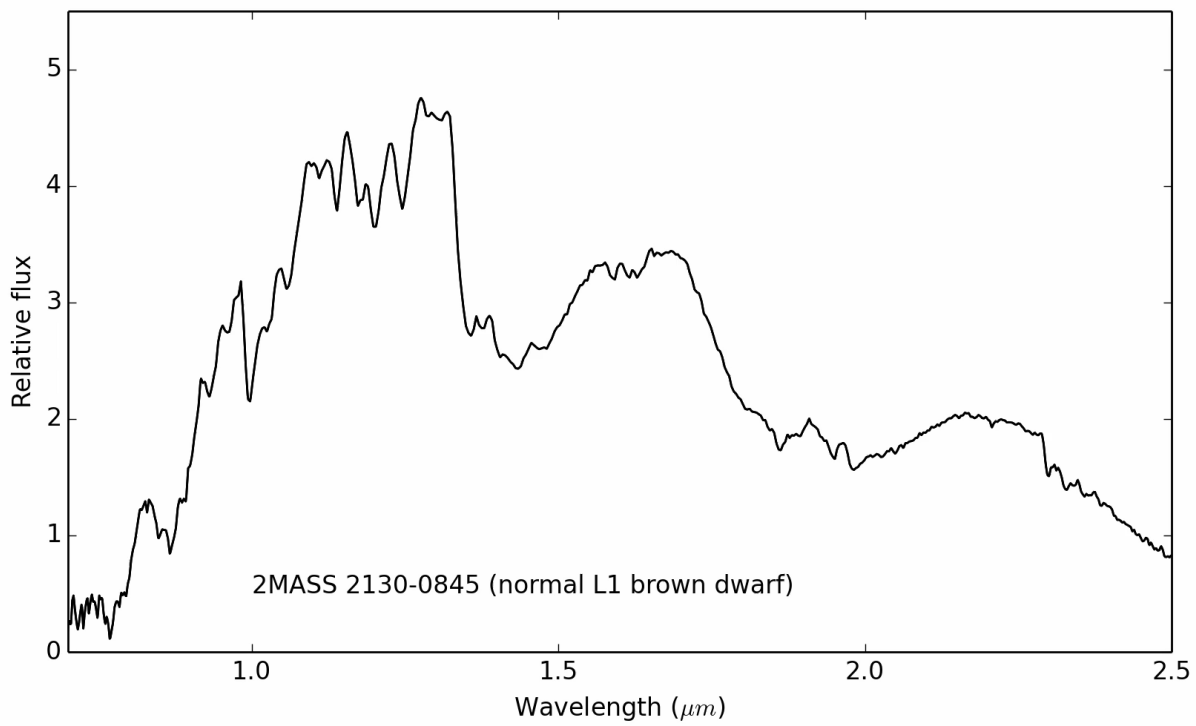
What we do with brown dwarfs

Moving Groups

Kinematic Fitting

Tracebacks

Red L dwarfs: redder in NIR, also have low gravity features



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What are they?

- Moving Group
  - A group of stars moving together through space
  - The product of a single burst of star formation

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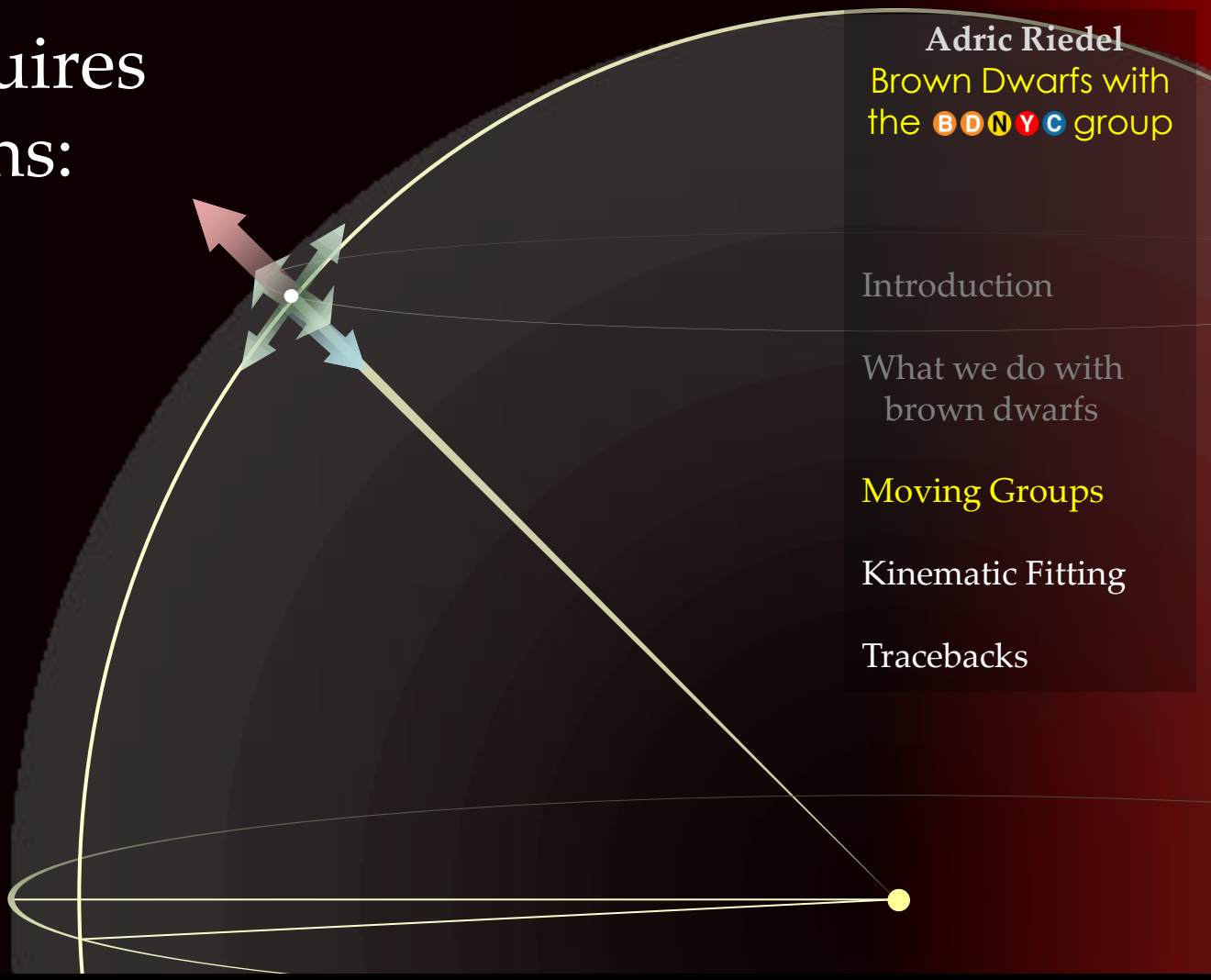
Kinematics requires six dimensions:

- RA
- DEC
- Parallax
- μ_{RA}
- μ_{DEC}
- RV

Now:
124000 parallaxes

After Gaia:
1000000000 parallaxes



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Many groups have been proposed, few are still thought to be real

- eps Cha 6 Myr
- eta Cha (Tiny cluster) 6 Myr
- TW Hya 3-15 Myr
- beta Pic 10-20 Myr
- Chameleon-Near 10-20 Myr
- Octans-Near 10-20,200 Myr
- Octans 20 Myr
- Tucana-Horologium 20-50 Myr
- Columba 20-50 Myr
- Carina 20-50 Myr
- Argus 30-50 Myr
- Carina-Vela 40-50 Myr
- Carina-Near 40-50 Myr
- IC 2391 Supercluster various
- B4 50 Myr
- AB Dor 50 or 120 Myr
- Pleiades (Cluster) 120 Myr
- Hercules-Lyra 250 Myr
- Castor 200-400 Myr
- Coma Berenices (Cluster) 400 Myr
- Ursa Major 500 Myr
- Hyades (Cluster) 650 Myr

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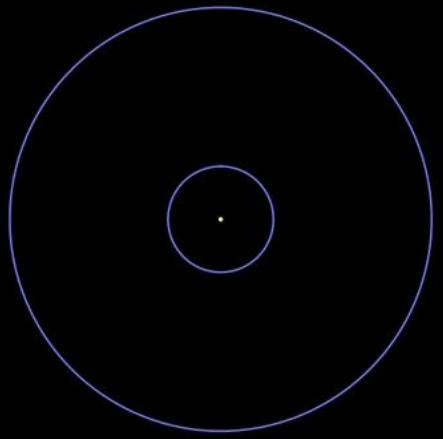

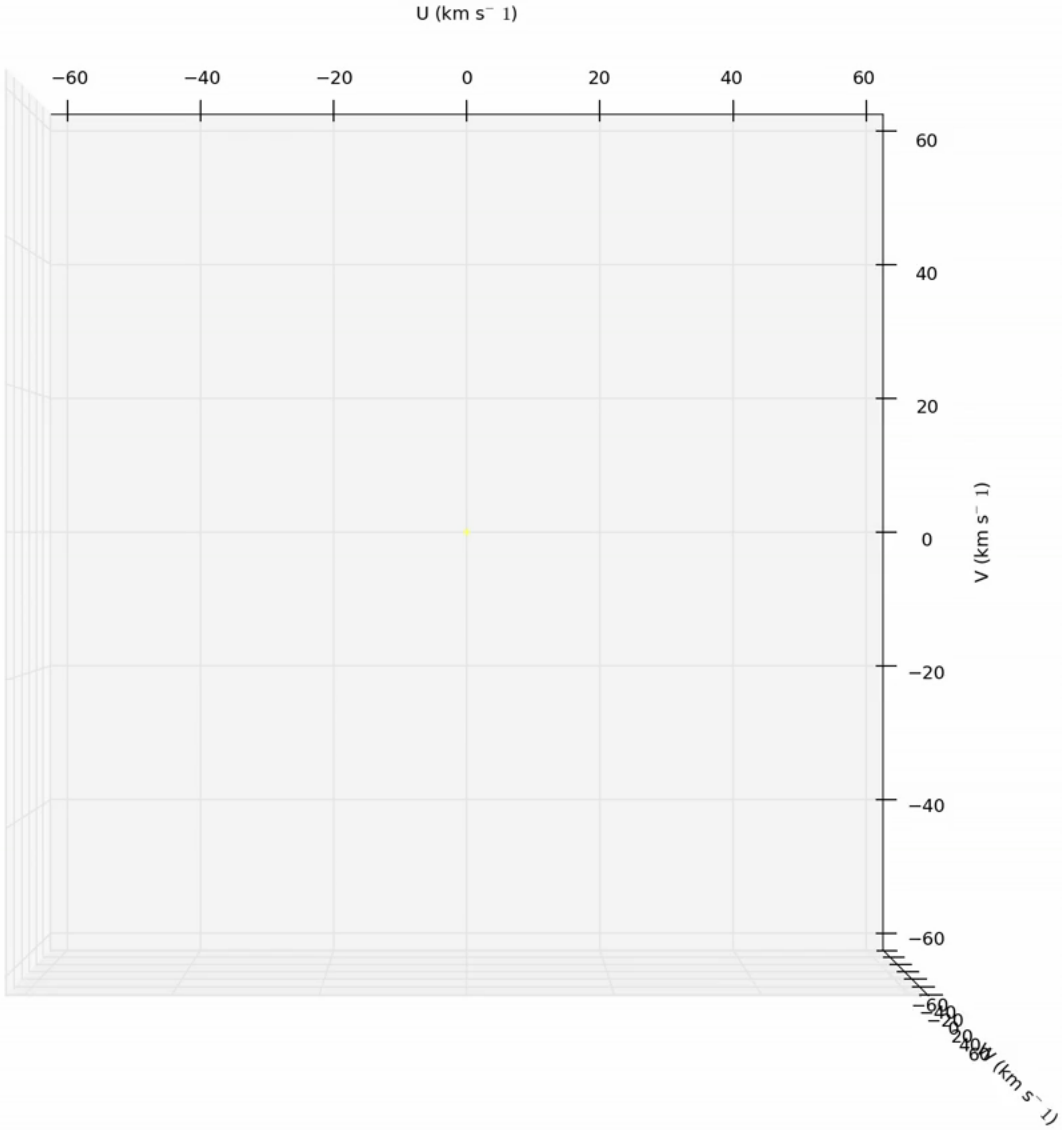
U (km s⁻ 1)
−60
−40
−20
0
20
40
60
60
40
20
0
−20
−40
−60
V (km s⁻ 1)
W (km s⁻ 1)

The expected proper motion (and RV) for a moving group member can be calculated at any RA and DEC.

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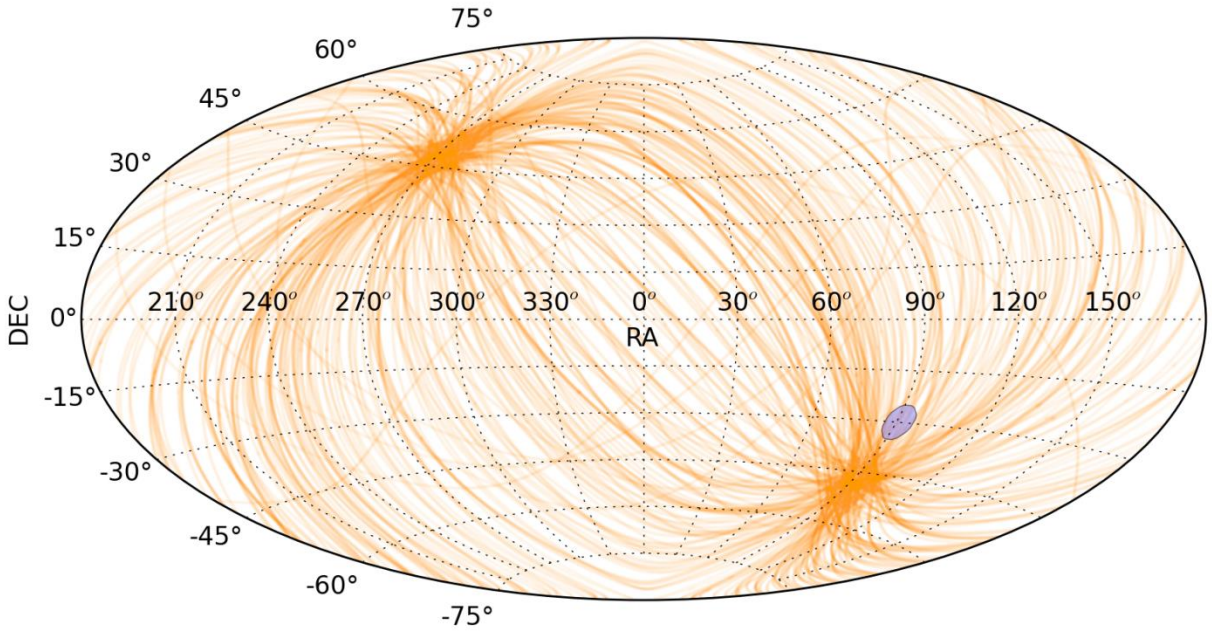

SCR 1425-4113AB: TW Hydra?

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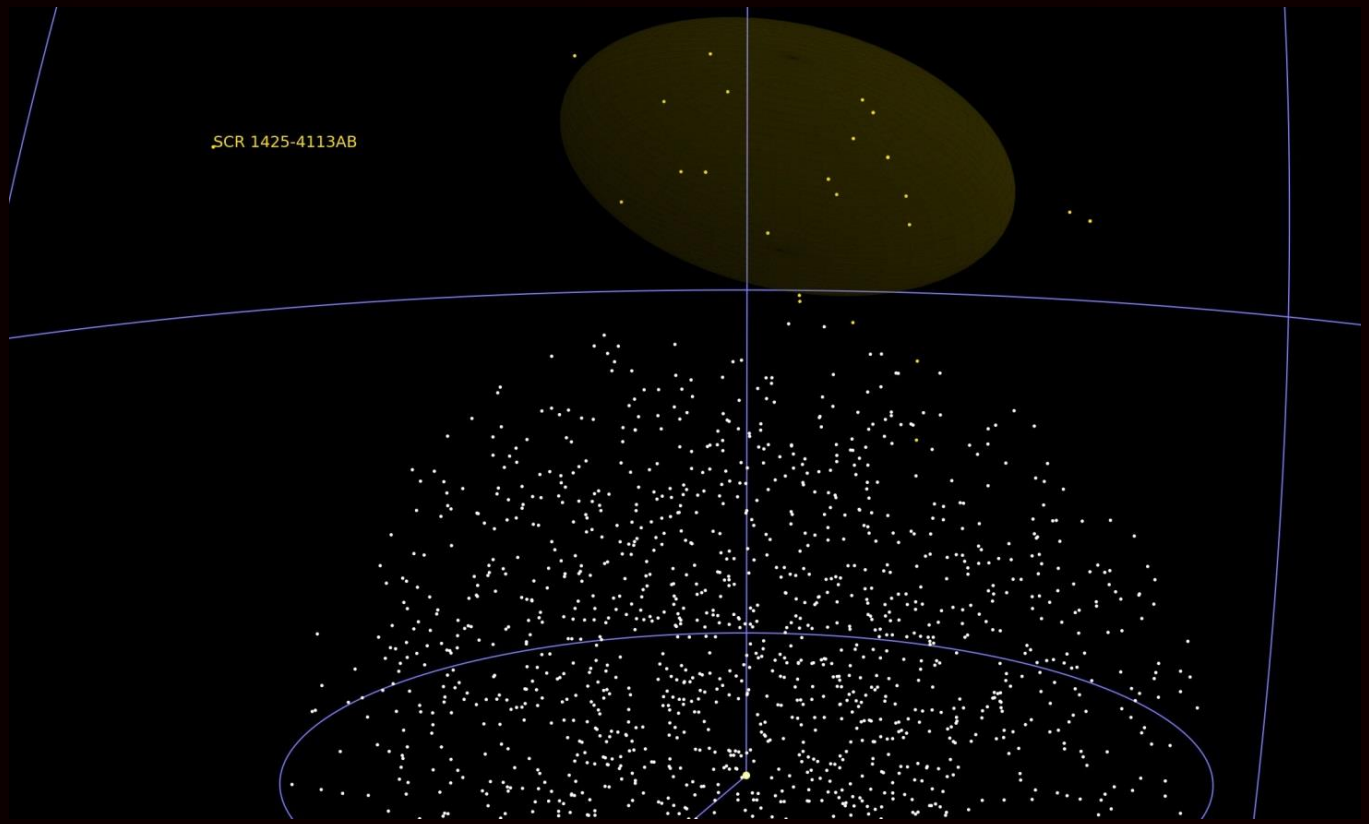

Riedel et al. (2014)

Introduction

What we do with brown dwarfs

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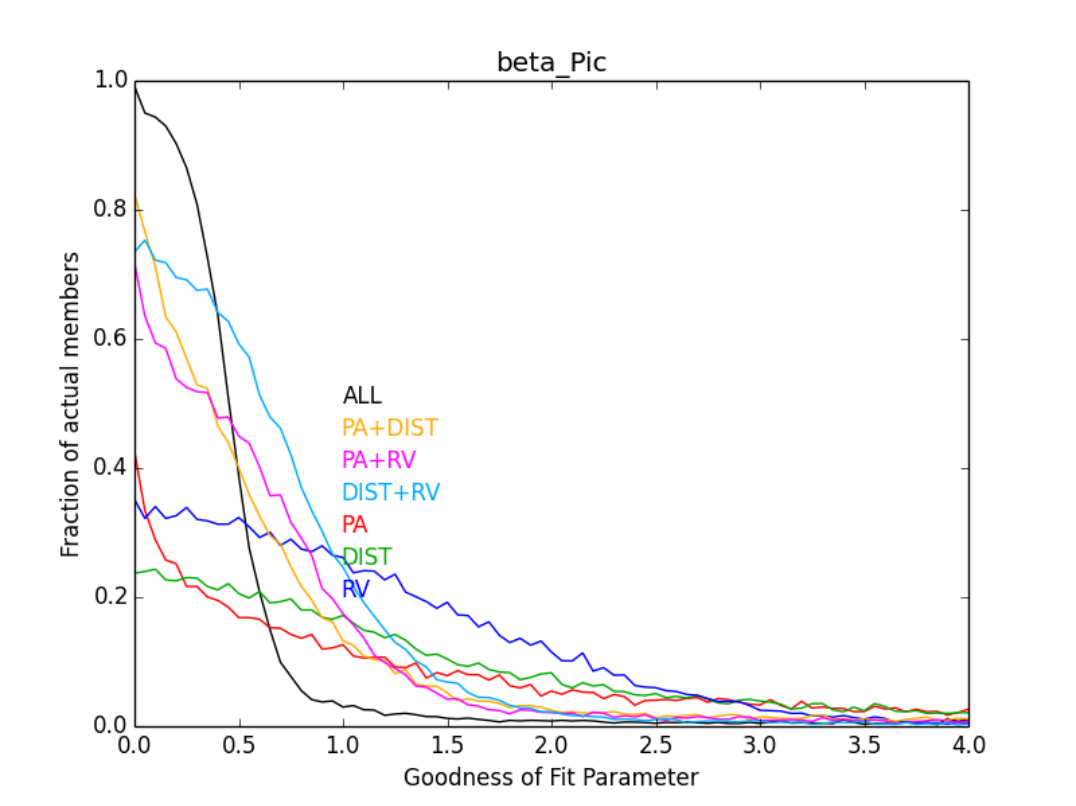
A simulation of 5 million stars drawn from realistic kinematic distributions (*without* field stars):



"What fraction of stars with this goodness-of-fit value are actually members?"

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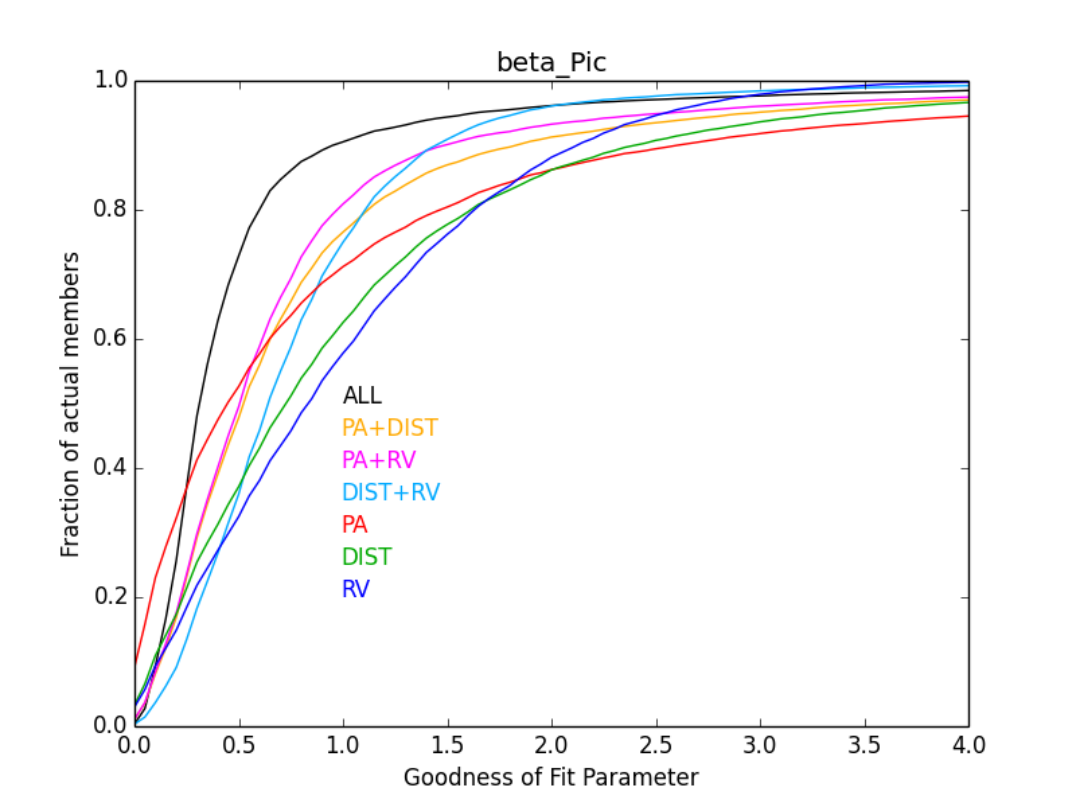
Brown Dwarfs with the BDNYC group

A simulation of 5 million stars drawn from realistic kinematic distributions:



"What is the fraction of members found when values up to a certain Goodness-of-Fit are accepted?"

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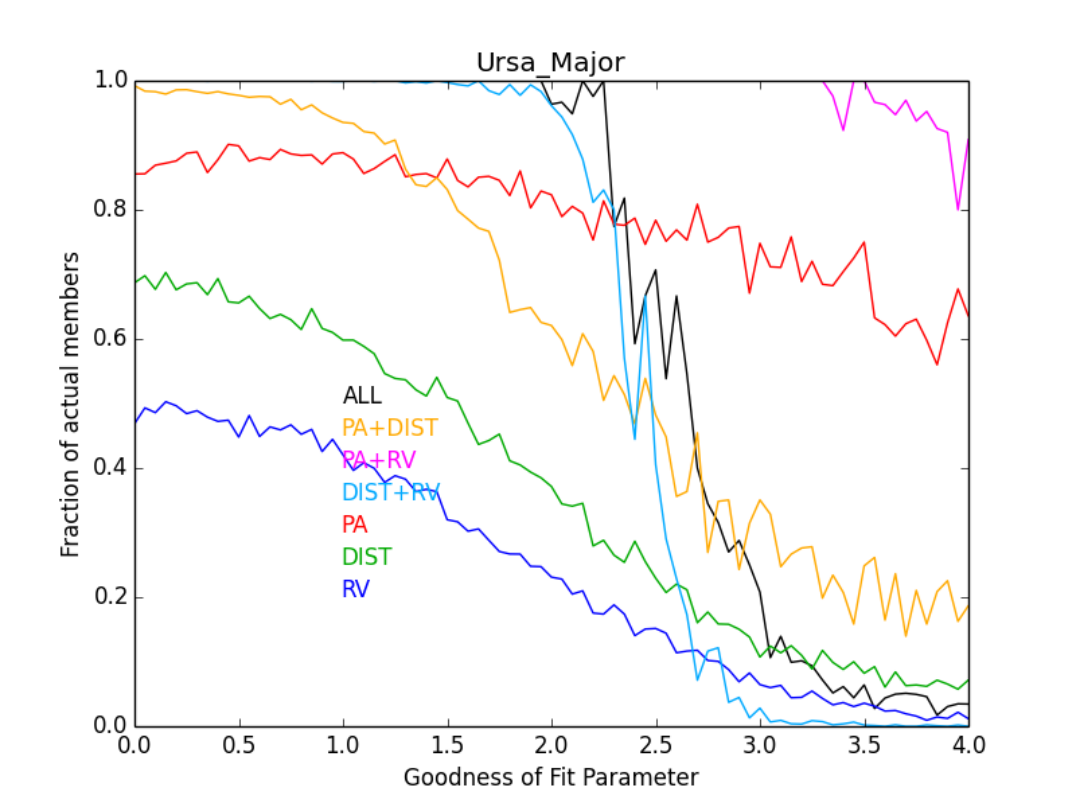
Ursa Major is easier to predict:



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Young Stars Checklist

Probably	UVW match to group motion	Not all young stars are in young moving groups; some field stars will match motion
Yes	Above main sequence	Young stars are physically larger. This could also be because of a binary, or a metal-rich star.
Yes	Low surface gravity	Young stars are physically larger, so their surface gravity will be lower.
Maybe	Li absorption	Lithium only comes from the Big Bang, and is quickly destroyed by stars. Only when VERY young. Not helpful for low-mass brown dwarfs.
Yes	Chemical Abundances	If all the stars formed from the same gas, they should have the same chemical abundances
Maybe	IR excess	Sign of a disk, only when VERY young.
Maybe	Red NIR colors	Young brown dwarfs may have dusty atmospheres
Yes	v*sin* i	Young stars (or tidally locked binaries) rotate quickly (faster than 10 km/s). The rotation produces powerful magnetic fields. Magnetic fields produce powerful flares, starspots, X-ray emission, and Hydrogen emission lines in the spectrum. M dwarf and brown dwarf activity is long-lived.
Yes	Flares/Variability	
Yes	H-alpha Emission	
Yes	X-rays	

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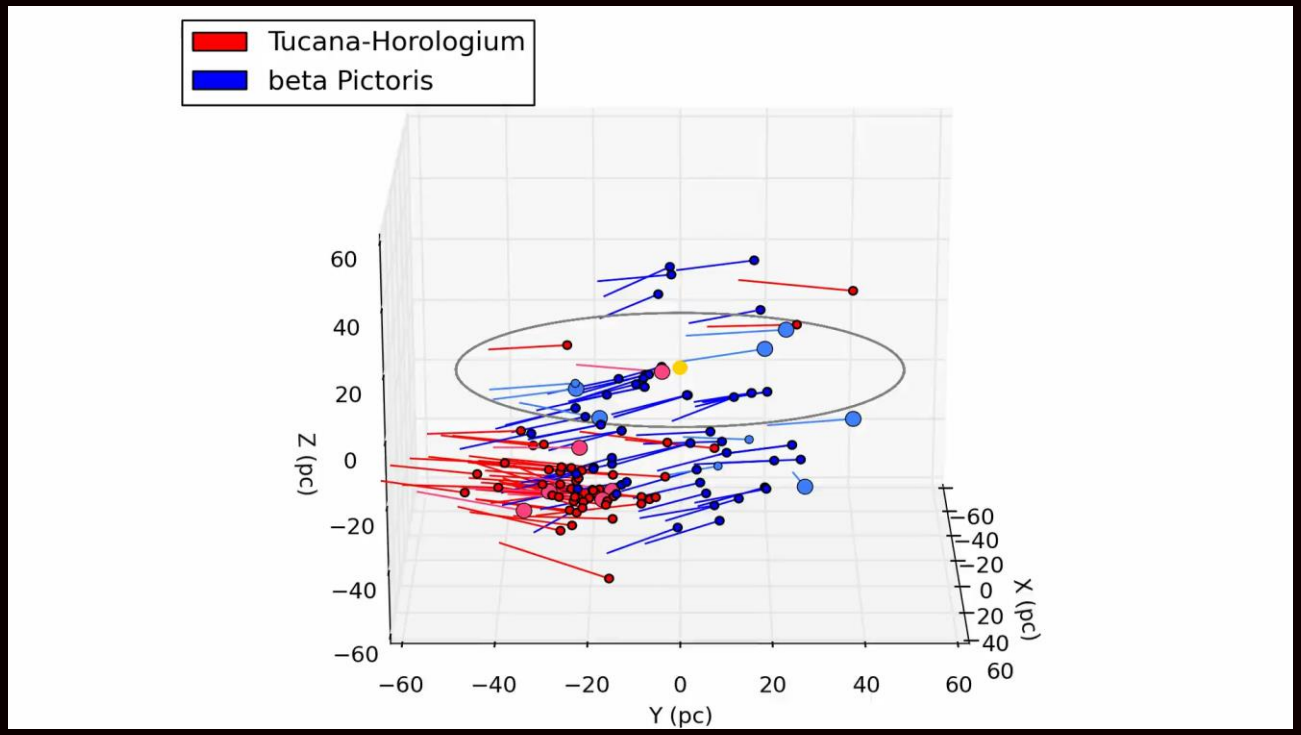
What else can we do with our young brown dwarfs?

- Brown dwarfs are larger, lighter circles.



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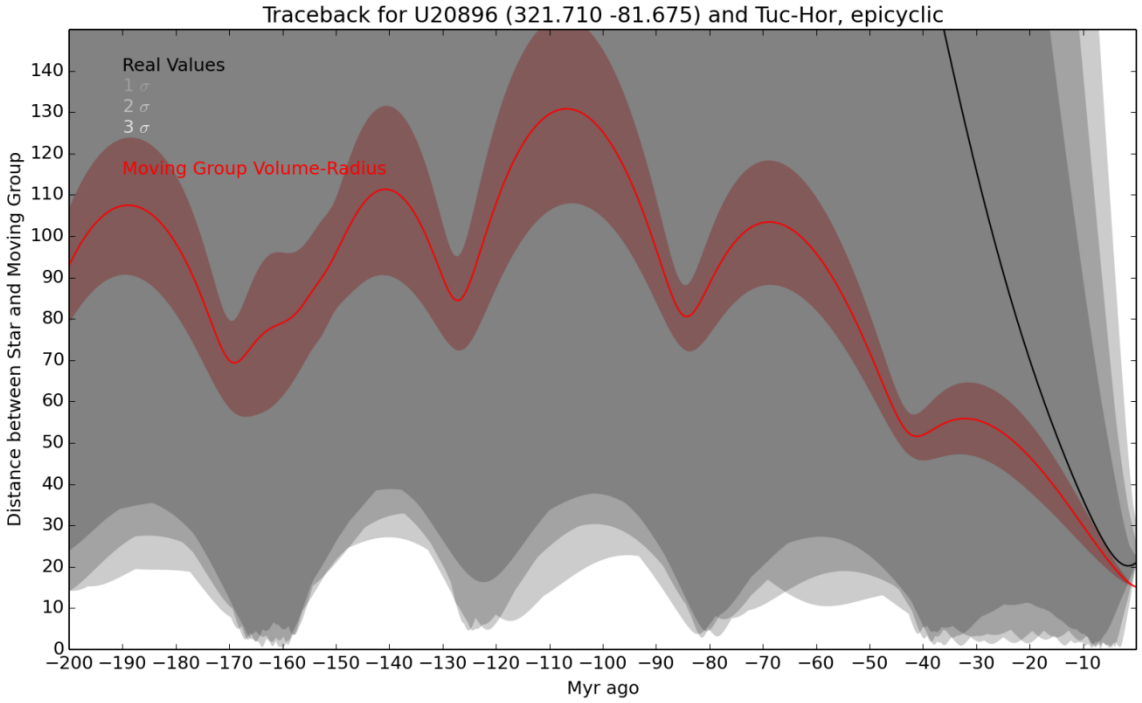
A graph of position as a function of time, relative to the center of Tuc-Hor



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Tuc-Hor does not trace back to itself

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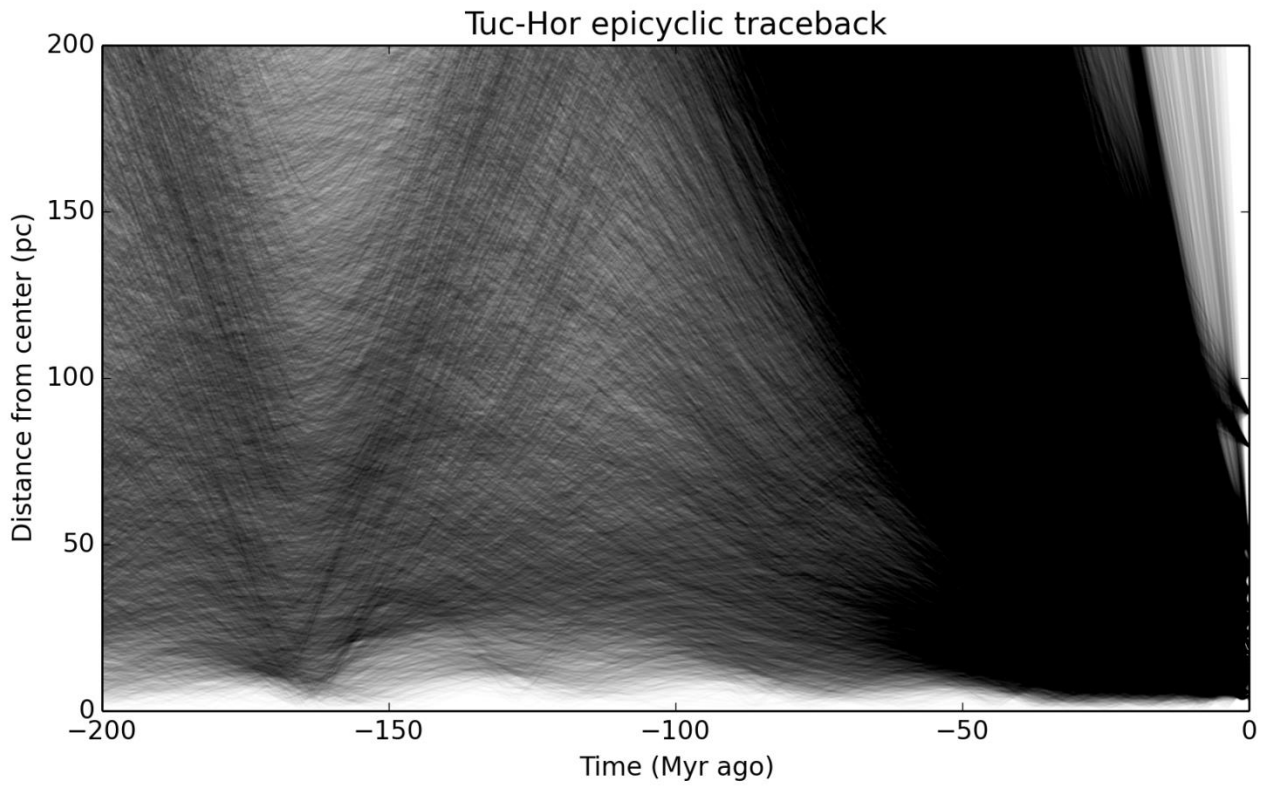
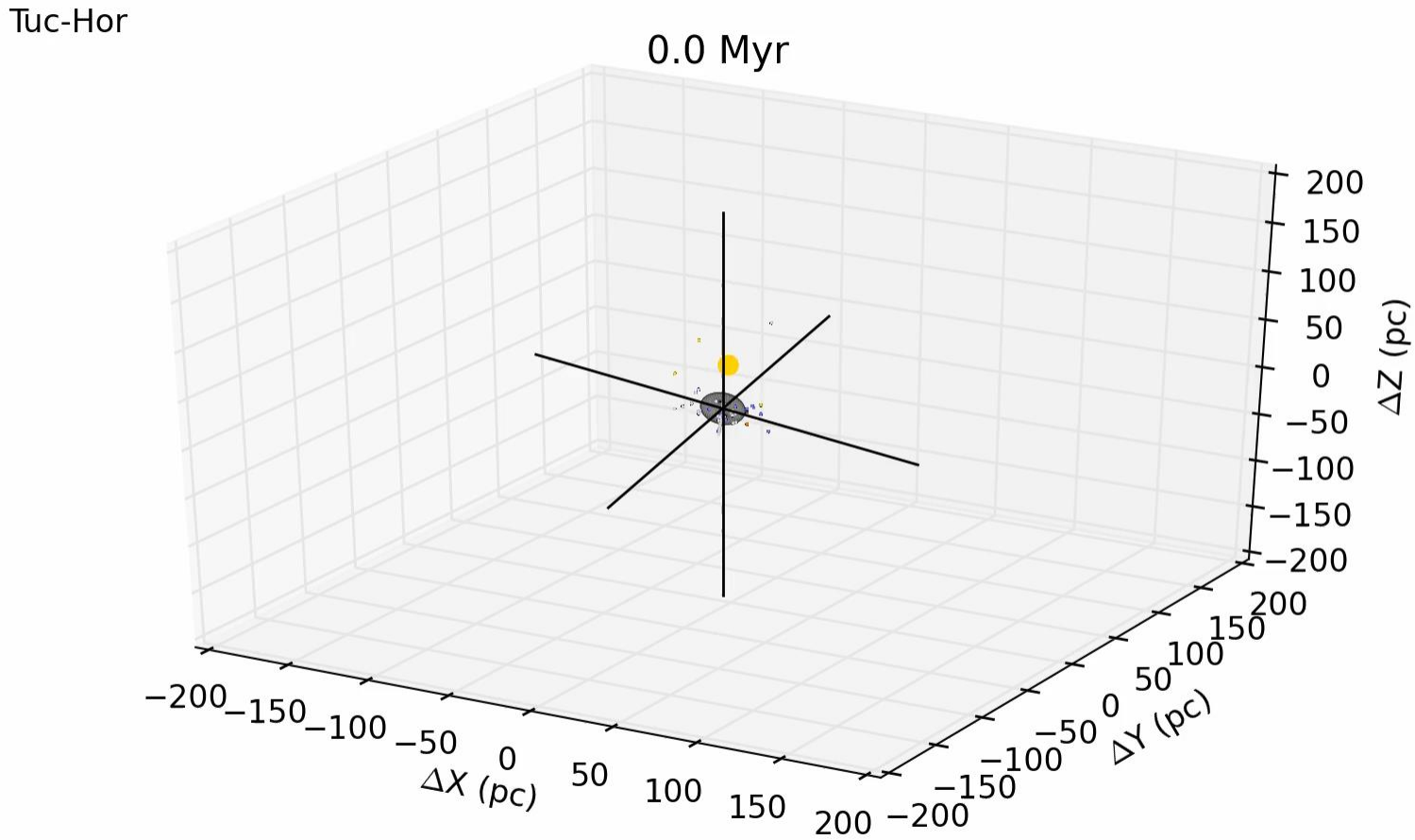
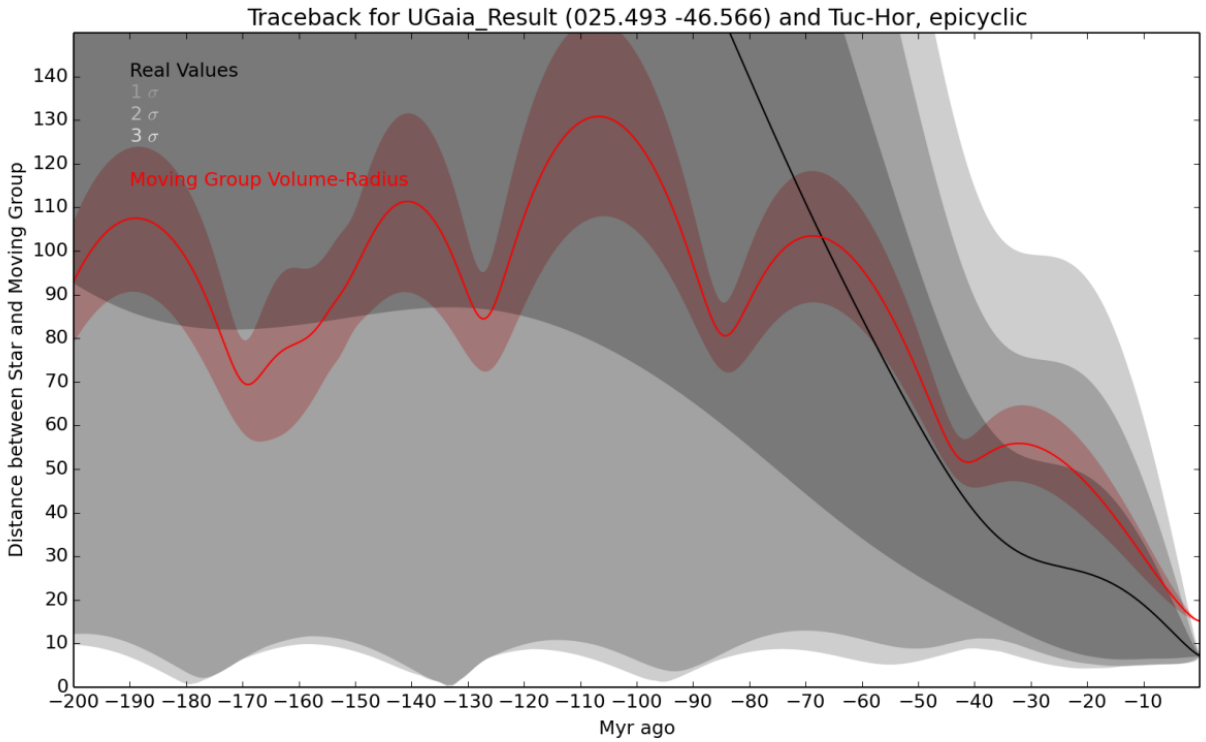



Tuc-Hor
0.0 Myr
ΔX (pc)
ΔY (pc)
ΔZ (pc)
−200
−150
−100
−50
0
50
100
150
200

Precision Gaia data will help this



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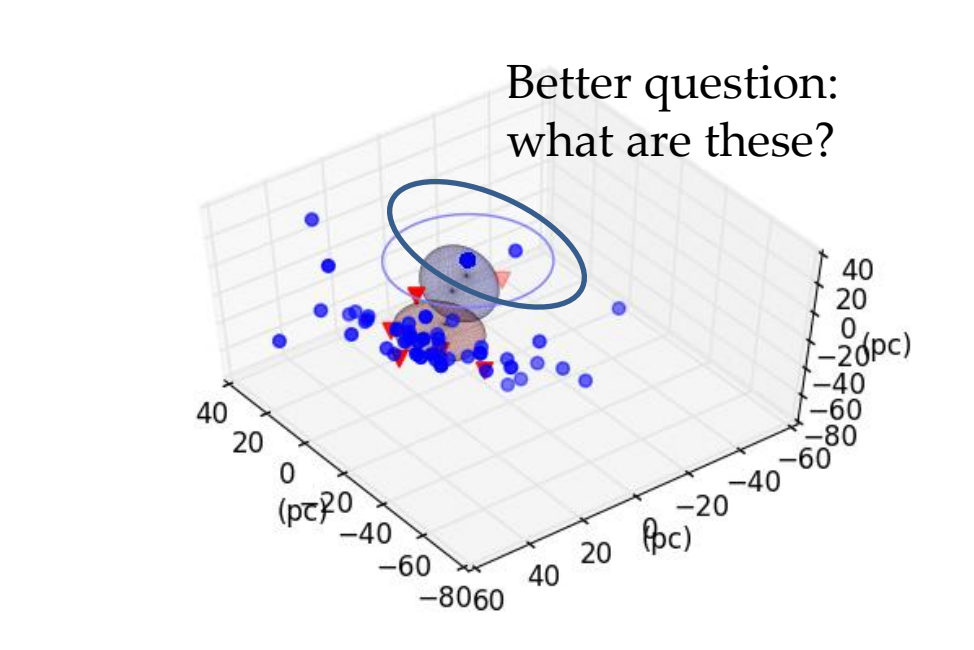
Does the position of a star within a star-forming region influence its mass?



The currently known brown dwarfs (red) in Tucana-Horologium are spatially distributed differently from the stars (blue).

Is this real? Probably not.

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Many Questions…

How does brown dwarf formation work?

What are the ages of brown dwarfs?

How do planets form?

How long does planet formation take?

How do stars evolve?

Does the position of a star within a star-forming region influence its mass?

What is the smallest star forming region?

Can a star forming region produce a single star?

What is the local star formation rate?

What is the local Initial Mass Function?

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