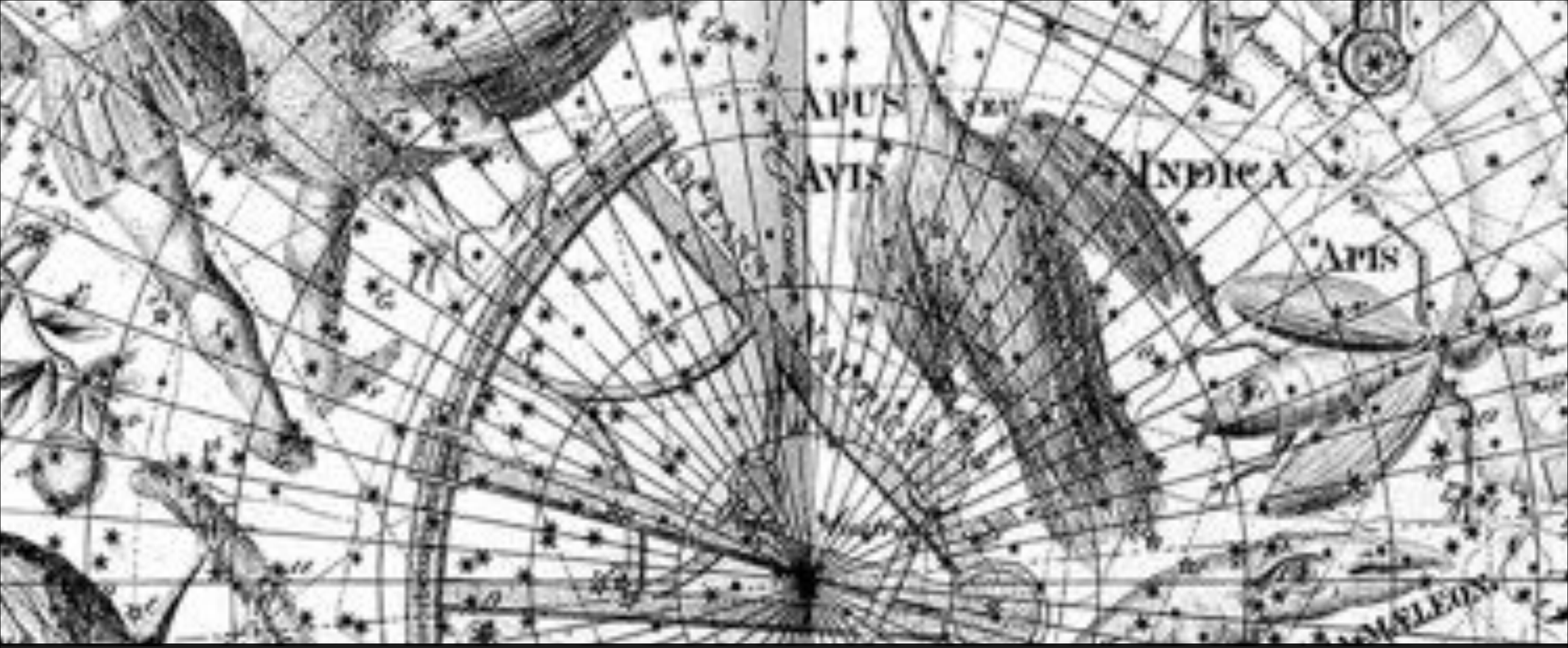


THE LOW-MASS MEMBERSHIP OF THE OCTANS ASSOCIATION

SIMON MURPHY
ARI/ZAH, UNIVERSITY OF HEIDELBERG
WITH WARRICK LAWSON, UNI. OF NEW SOUTH WALES

ASTROSMURPH

SIMONMURPHY.ME

UNIVERSITÄT HEIDELBERG
ZUKUNFT SEIT 1386

THE LOW-MA… …SHIP OF THE OCTANS… …TION

…a parable for Gaia

…UNIVERSITY OF HEIDELBERG
…WARRICK LAWSON, UNI. OF NEW SOUTH WALES

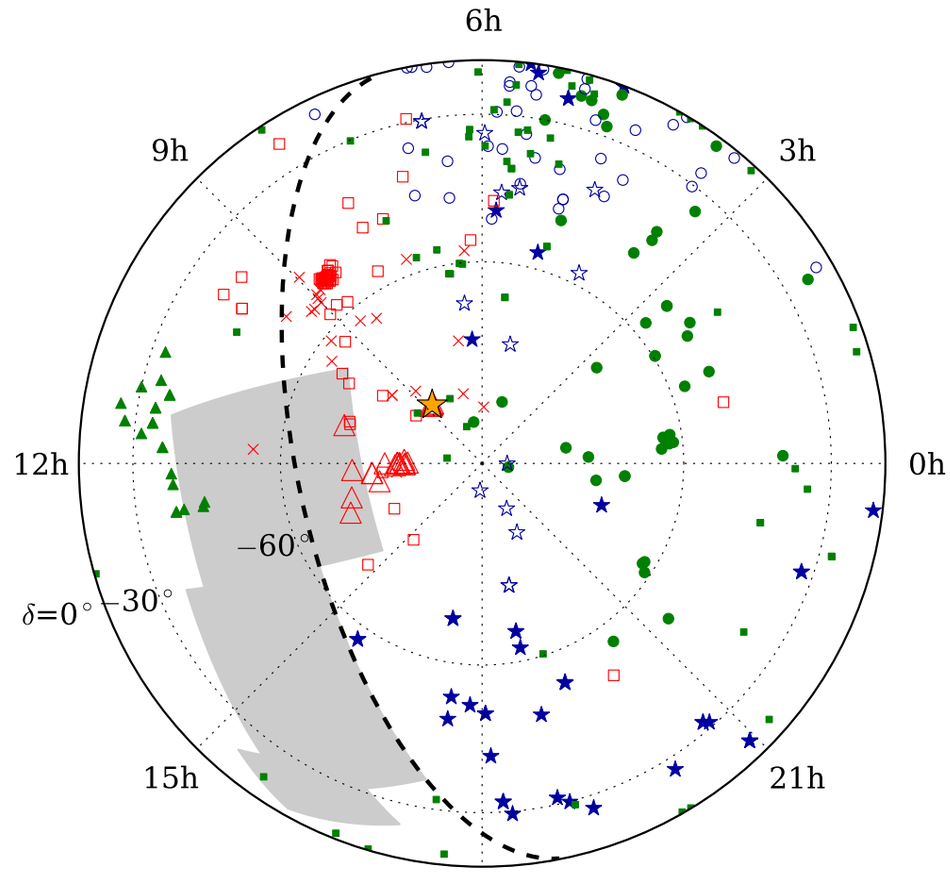
ASTROSMURPH

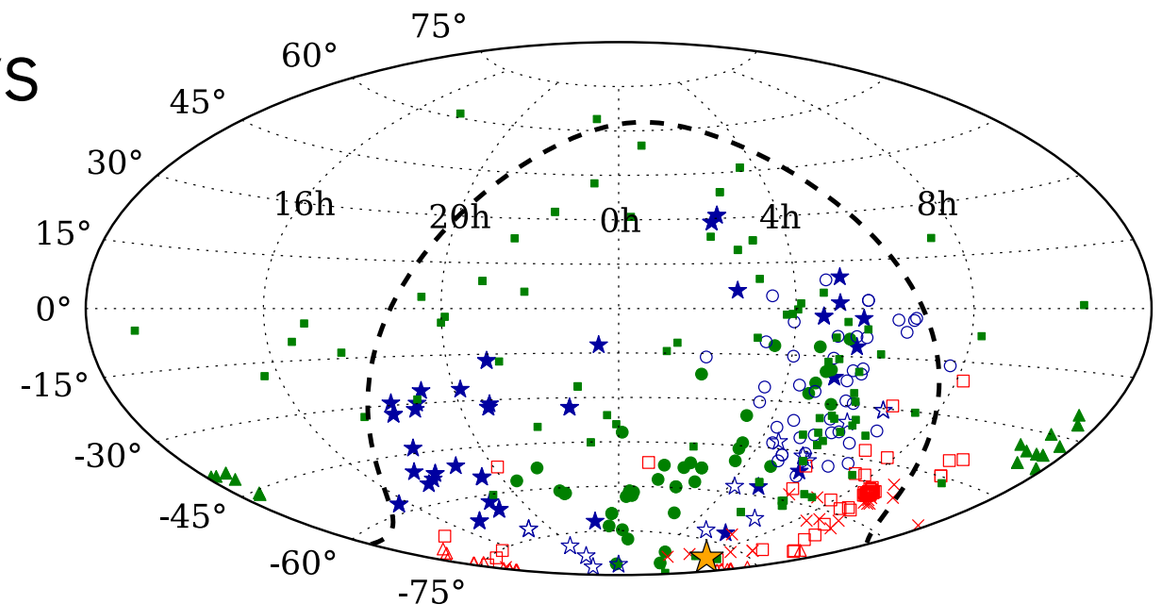
SIMONMURPHY.ME

UNIVERSITÄT HEIDELBERG
ZUKUNFT SEIT 1386

YOUNG NEARBY ASSOCIATIONS

- Low-mass and BD members are benchmarks (IMF, DISKS, PLANETS)
- Absolute ages uncertain (x~2)
- Powerful new statistical techniques becoming useful
- *Hipparcos* and multi-λ surveys a game-changer, <u>BUT</u>
- Spectroscopy still vital





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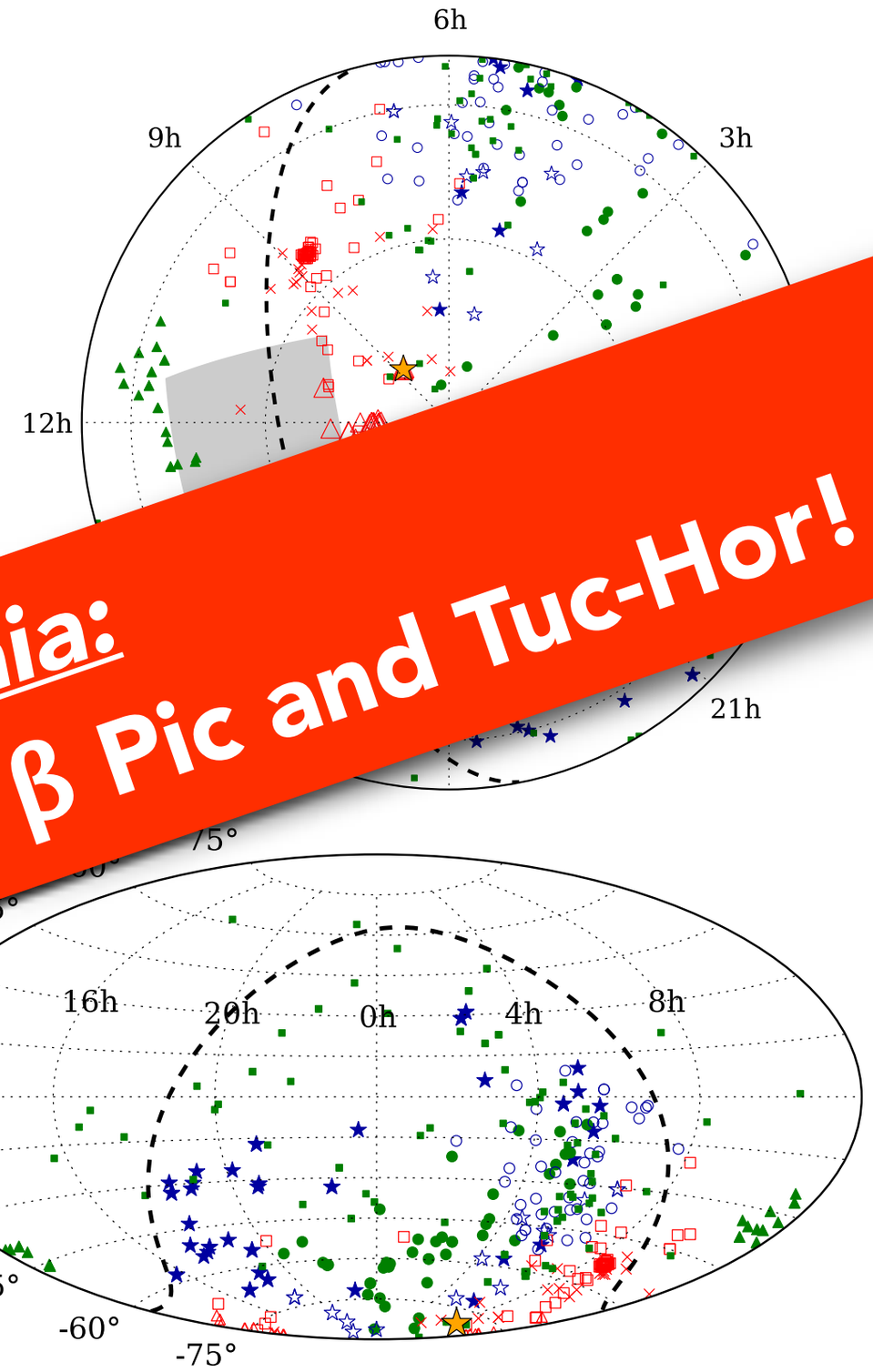
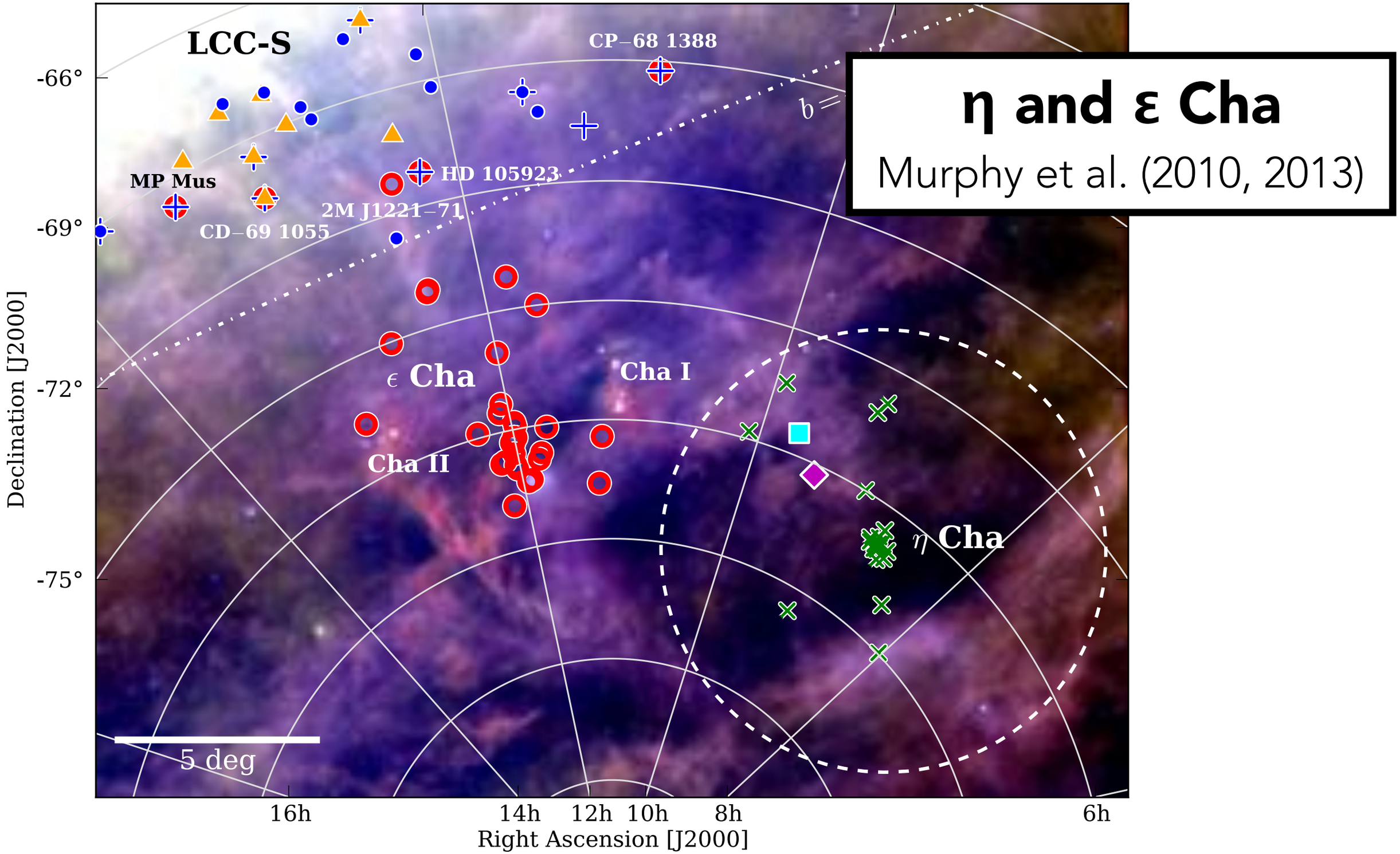


Lesson 1 for Gaia:
More out there than TW Hya, β Pic and Tuc-Hor!

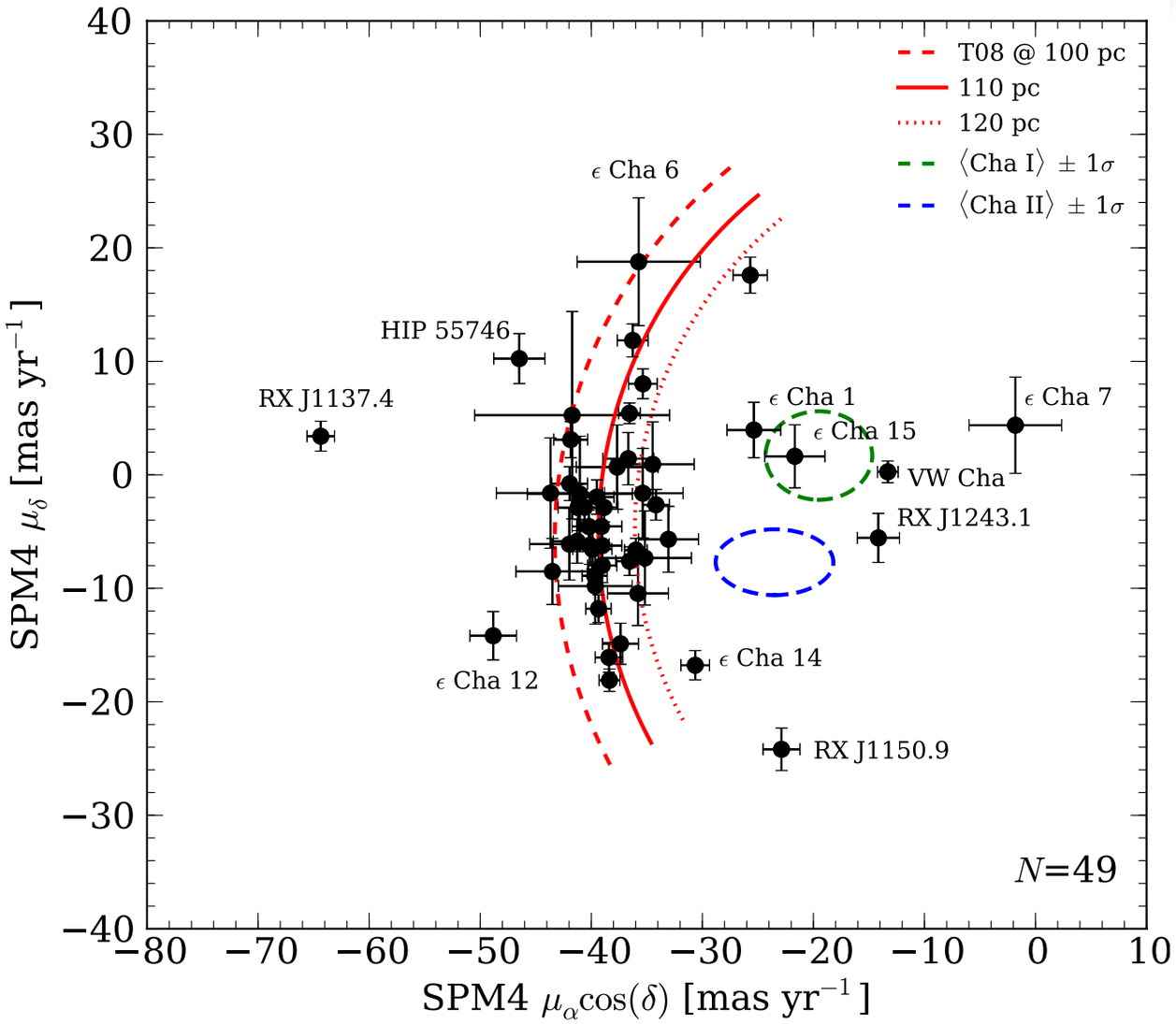
YOUNG NEARBY ASSOCIATIONS

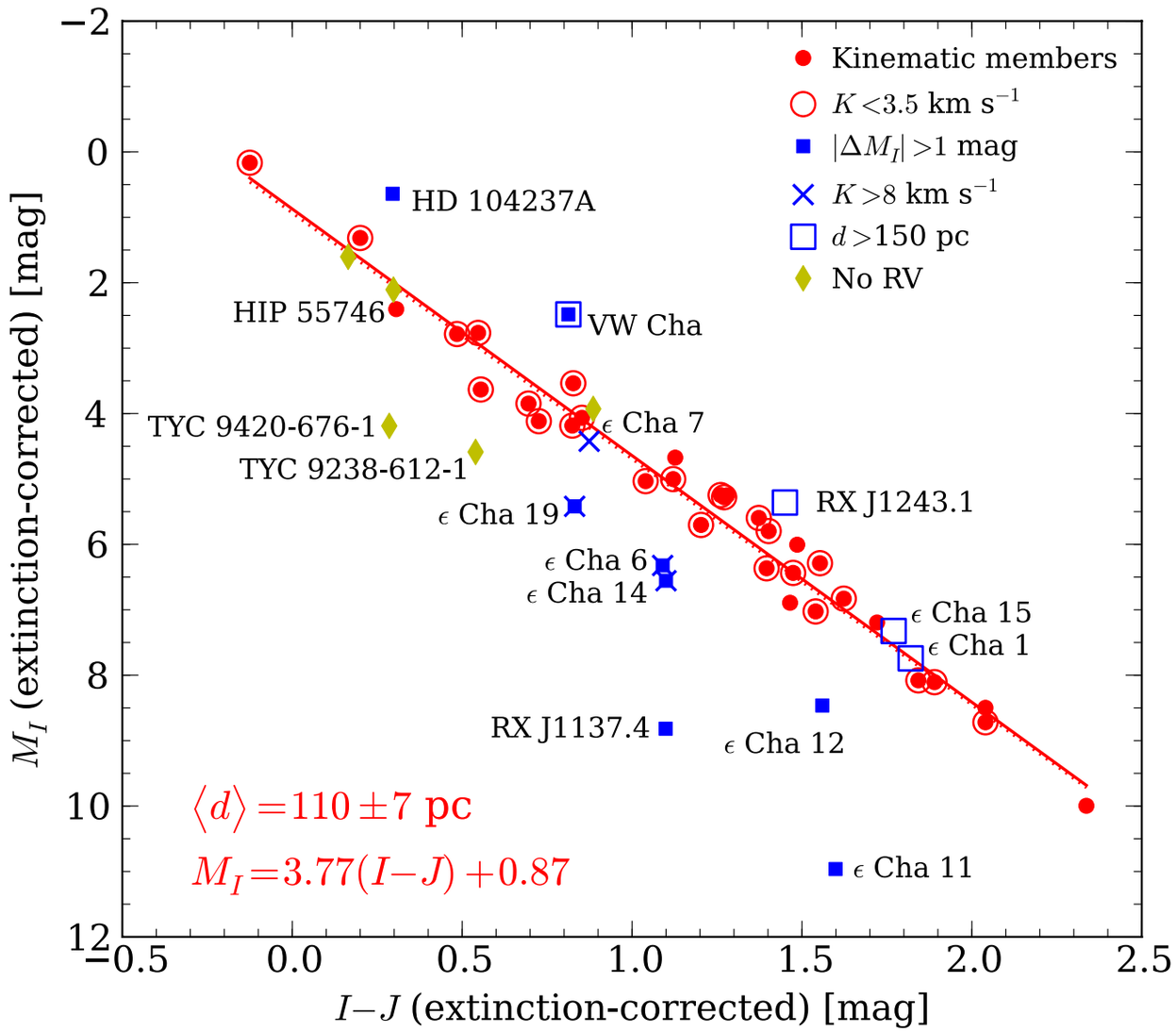


η and ε Cha

Murphy et al. (2010, 2013)

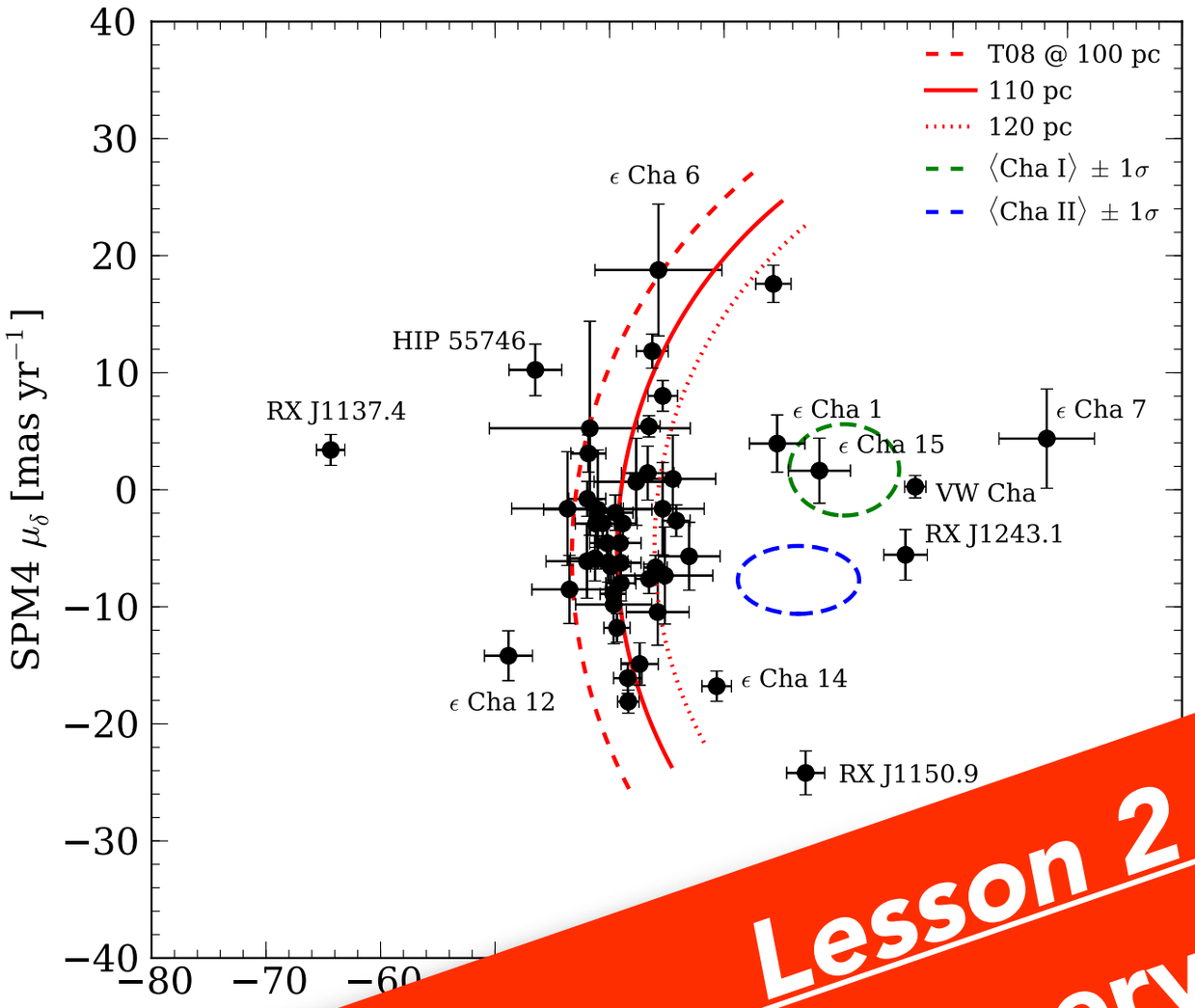
YOUNG NEARBY ASSOCIATIONS

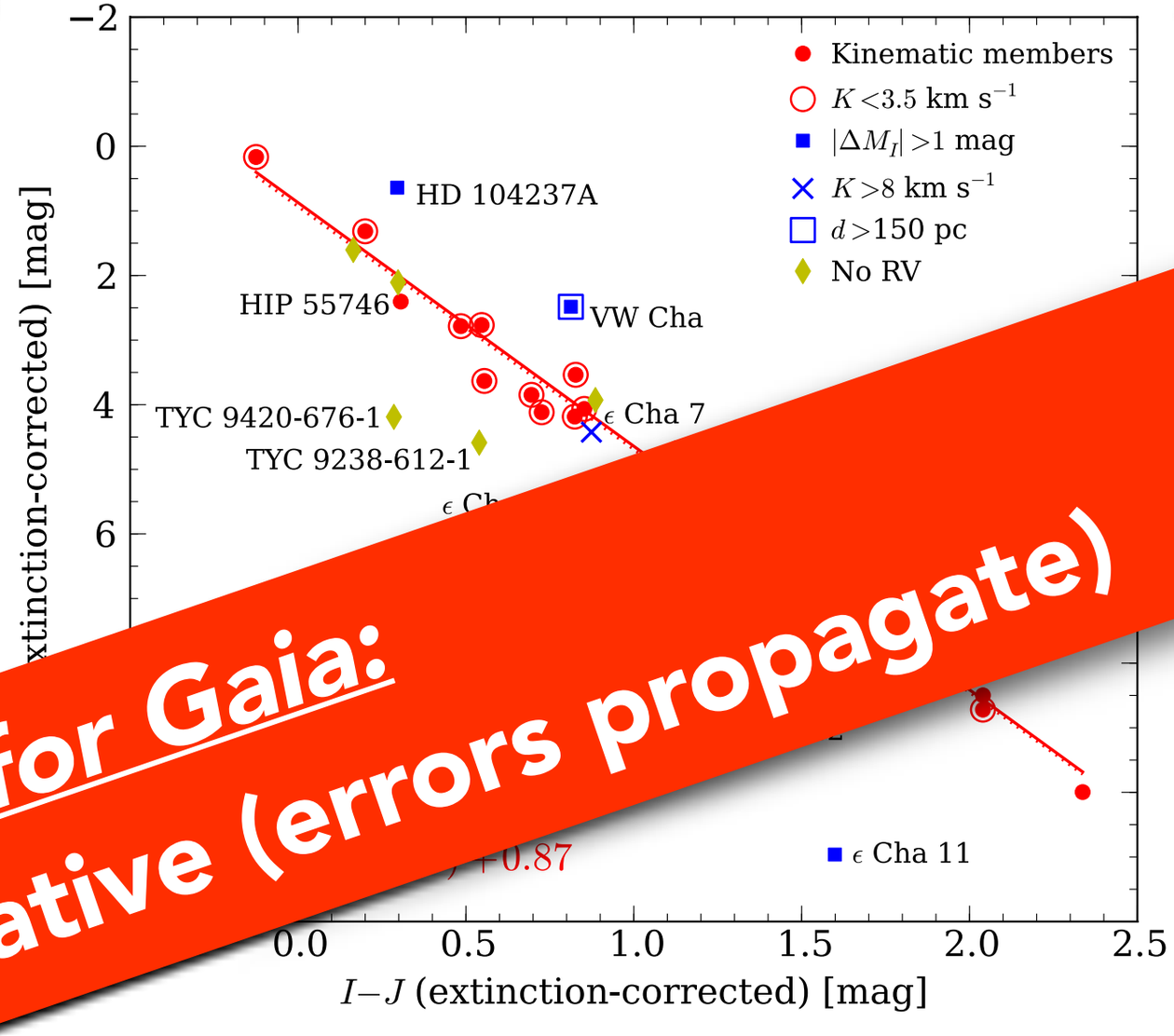




- Two distinct populations, many non-members
- Not just PMs: **μ, d_{kin}, CMD, RV, Li, low-g, X-ray, IR…**

YOUNG NEARBY ASSOCIATIONS





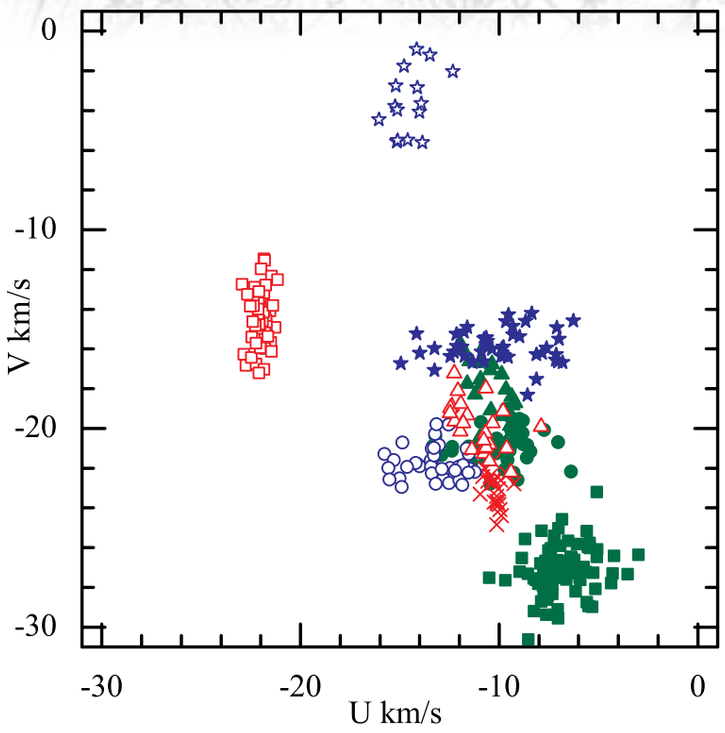
Lesson 2 for Gaia:

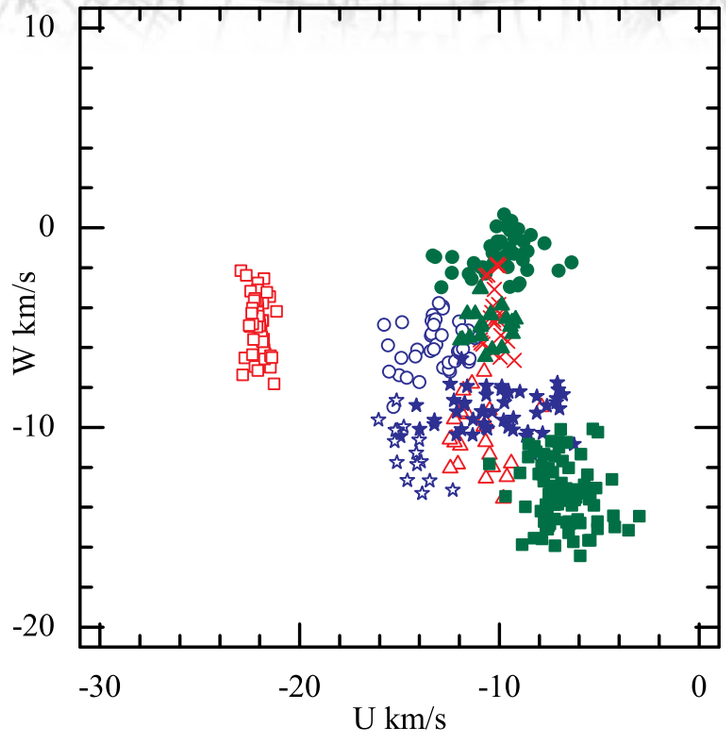
Be holistic and conservative (errors propagate)

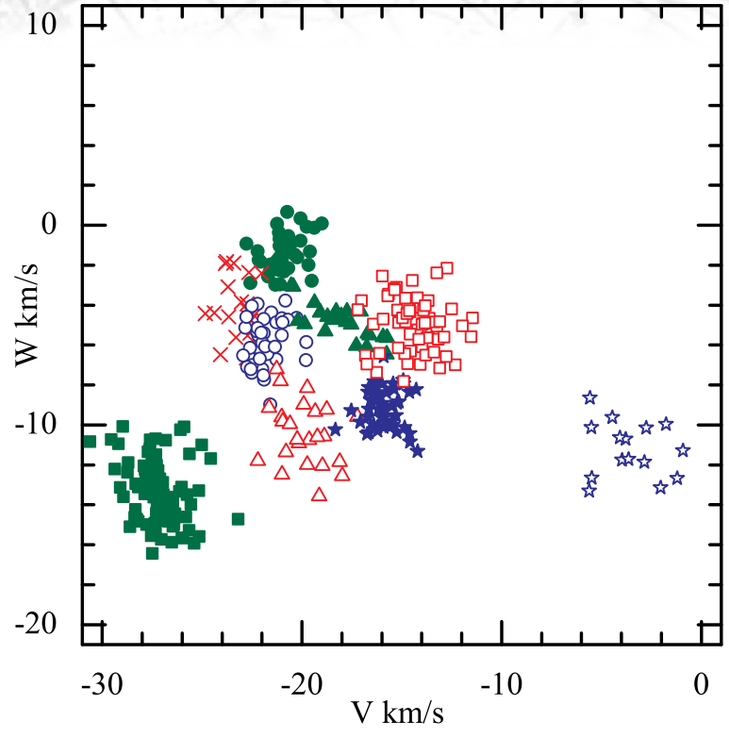
…ations, many non-members

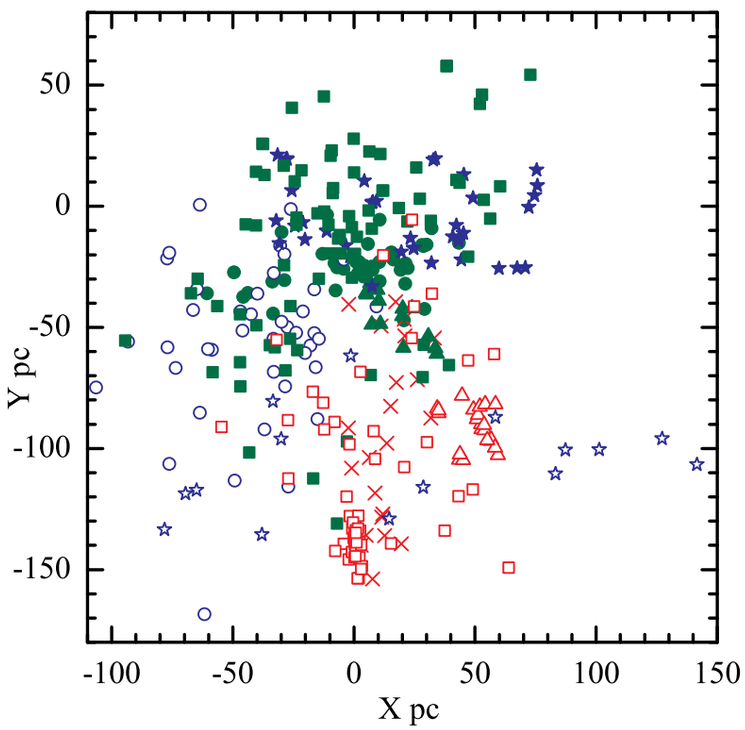
…t just PMs: **μ, d_{kin}, CMD, RV, Li, low-g, X-ray, IR…**

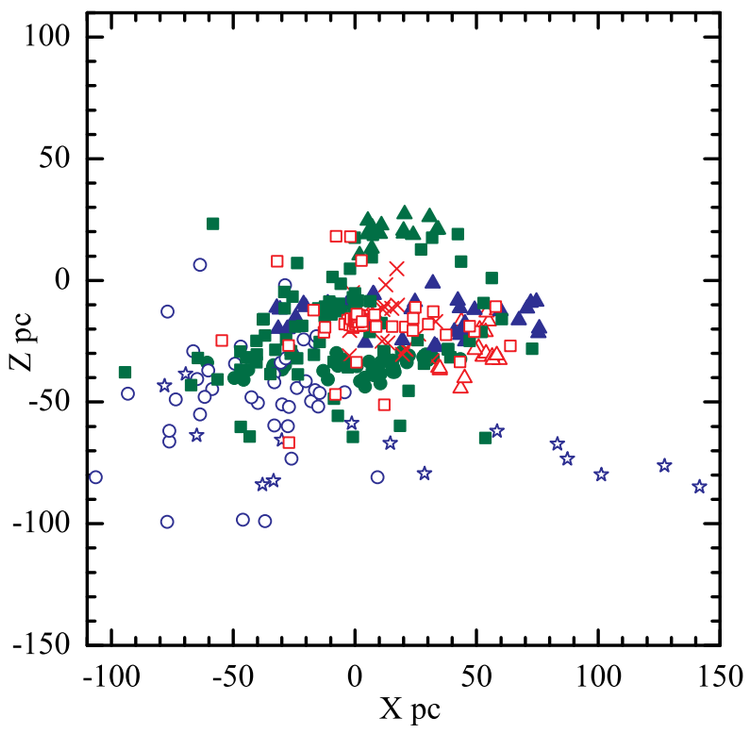
YOUNG NEARBY ASSOCIATIONS

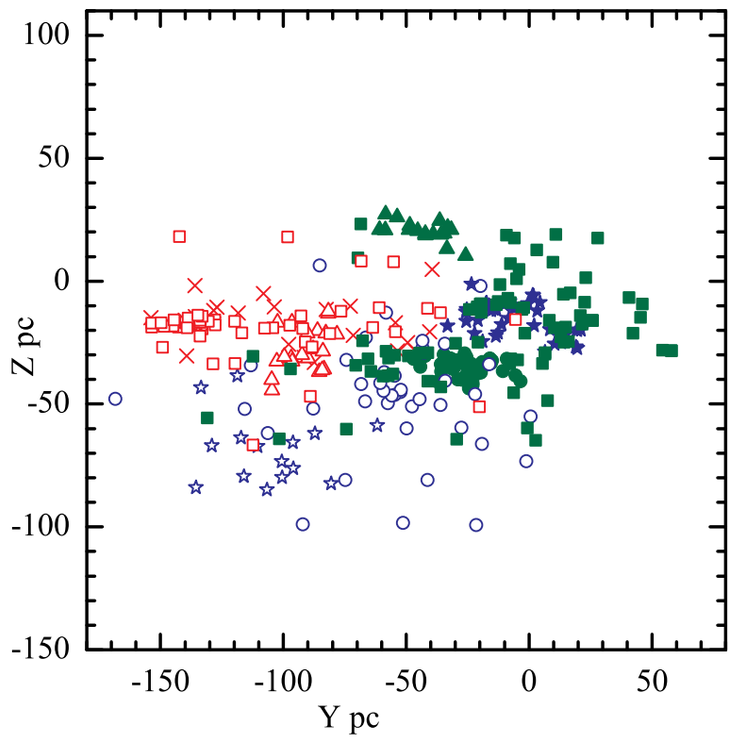






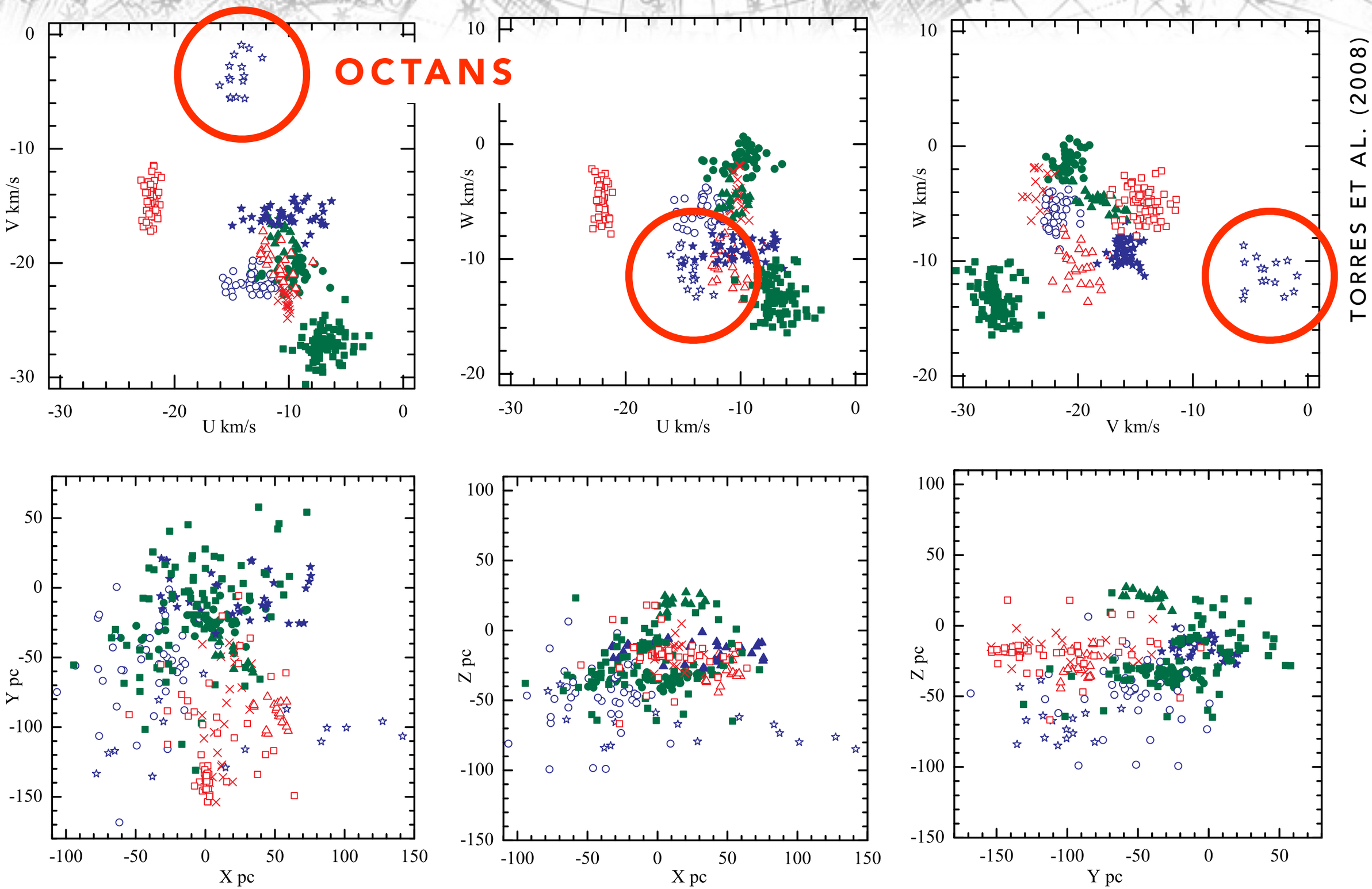




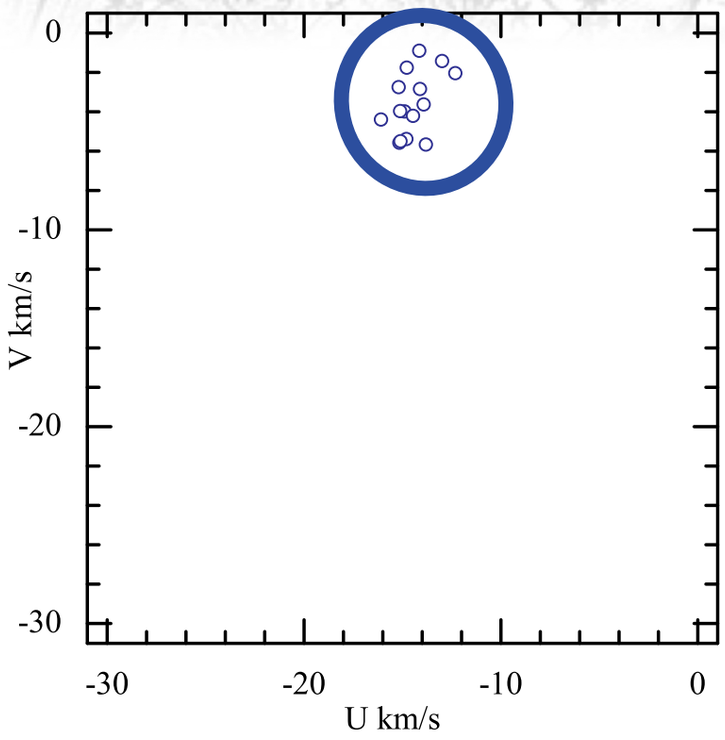


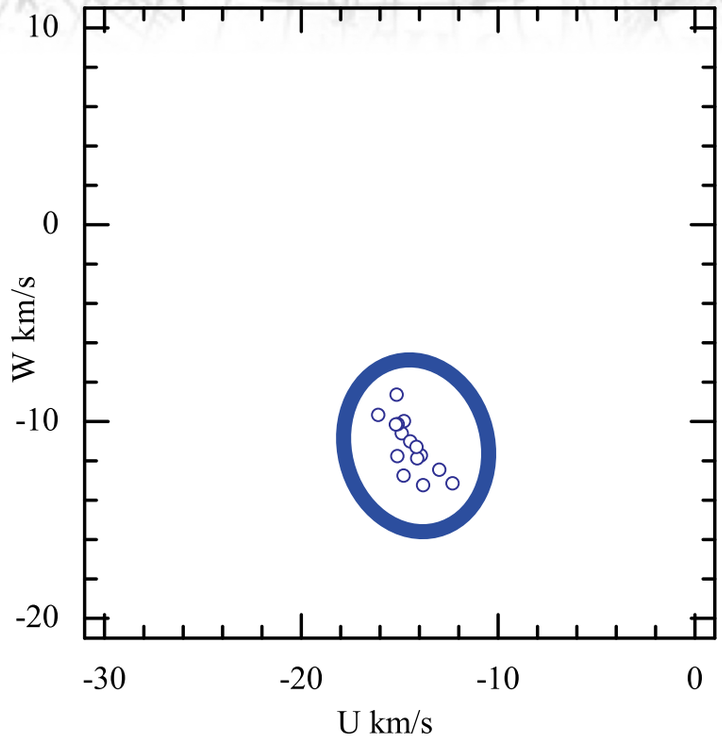
TORRES ET AL. (2008)

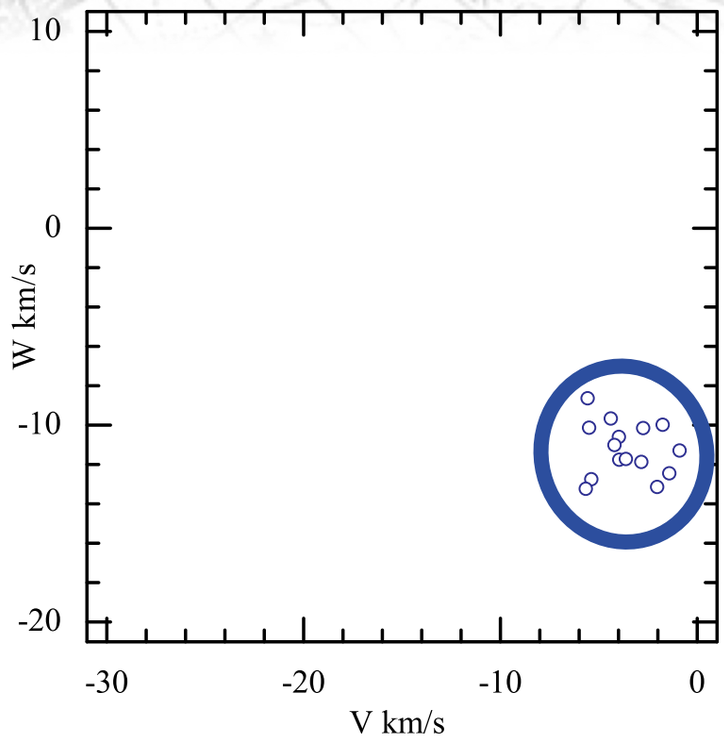
YOUNG NEARBY ASSOCIATIONS



THE OCTANS ASSOCIATION







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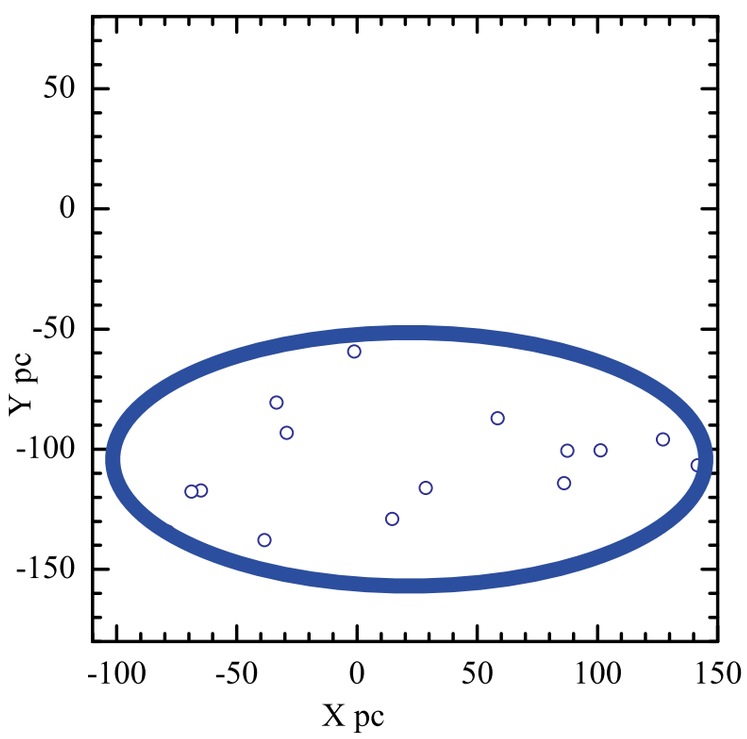
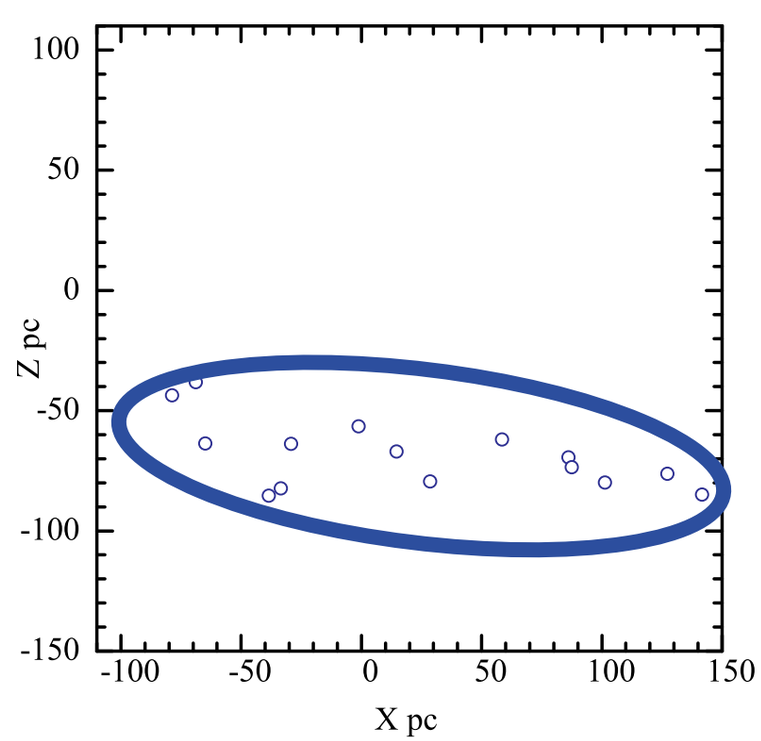
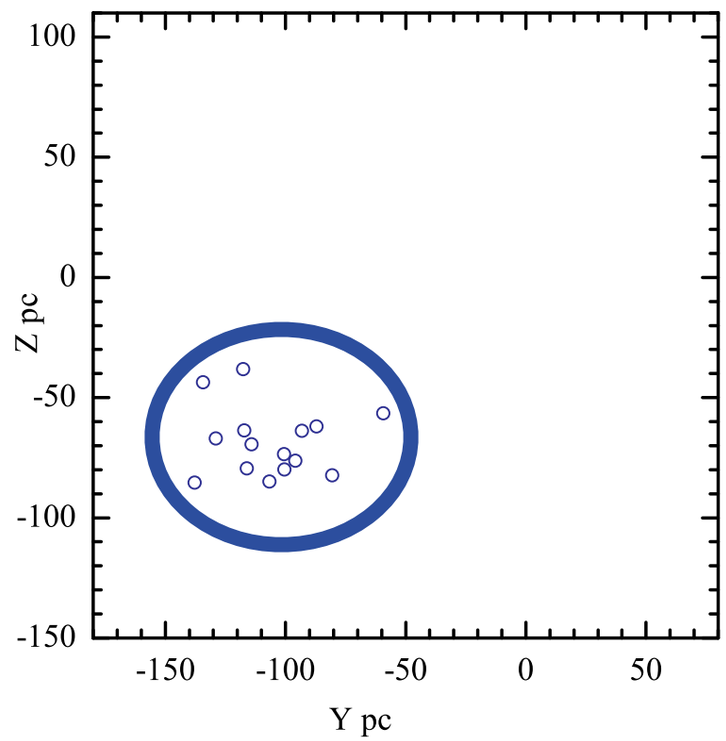
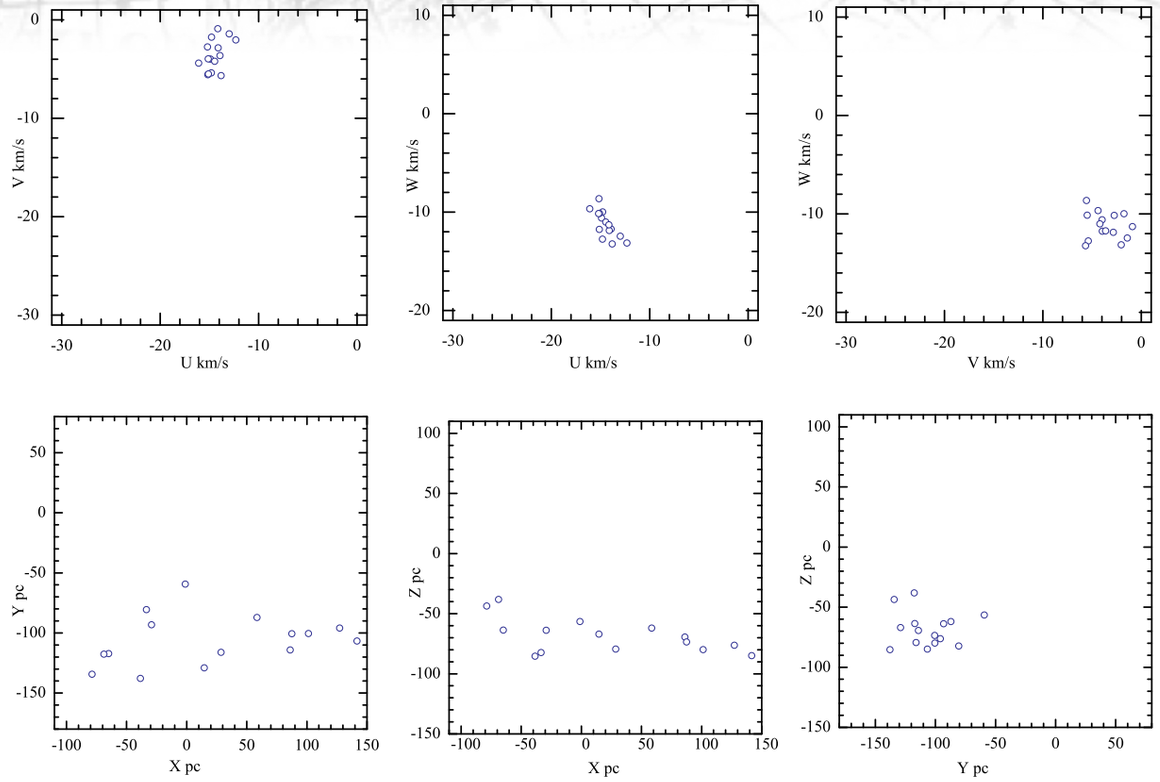






THE OCTANS ASSOCIATION

- 15 FGK stars, none in *Hipparcos*
- Two visual binaries
- **<d> = 141 pc (kinematic!)**
- *v*sin*i* = 20-200 km/s
- Elongated in X dimension
- **Age 10-20 Myr?**



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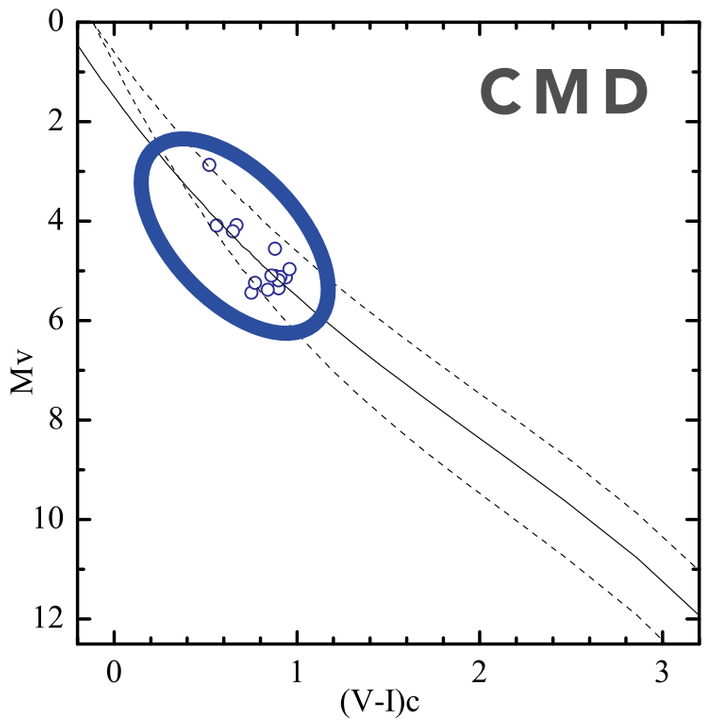
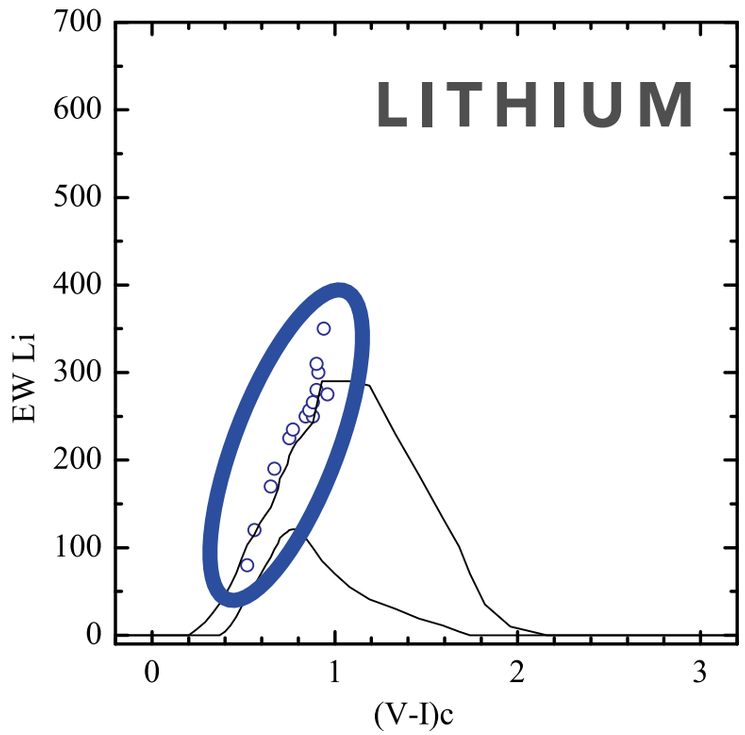
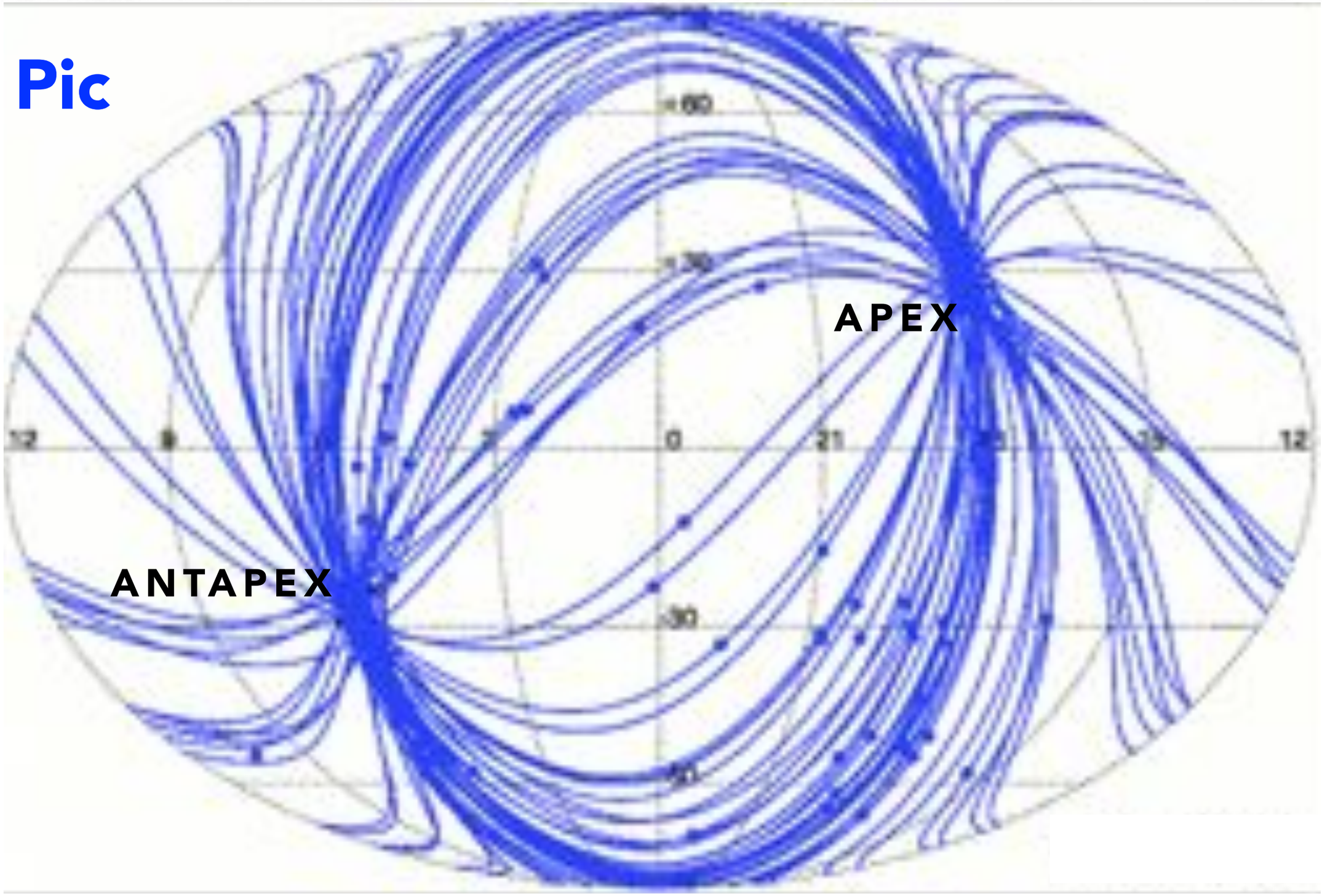




CONVERGENCE?

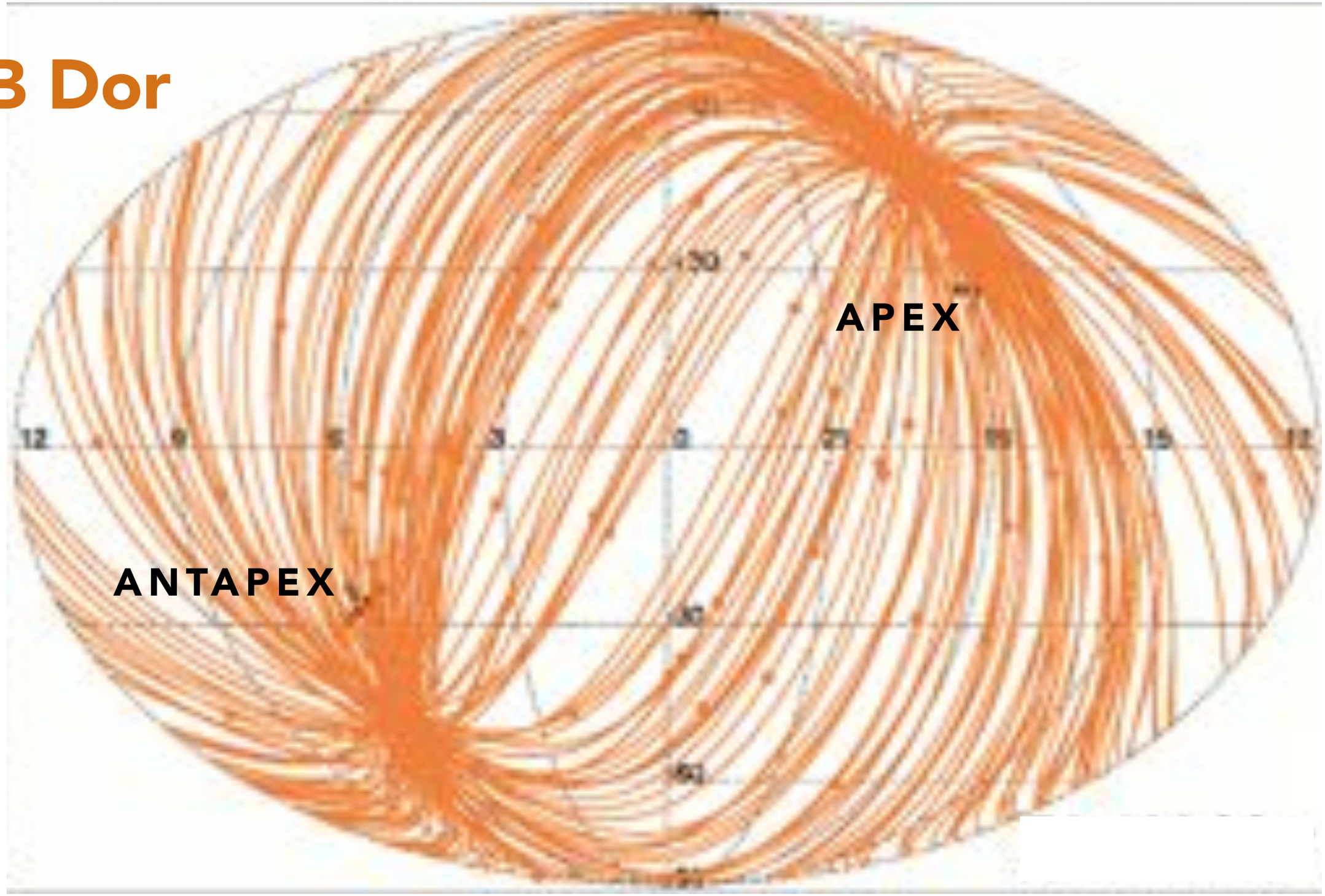
β Pic



ADRIC RIEDEL (HUNTER COLLEGE/AMNH)

CONVERGENCE?

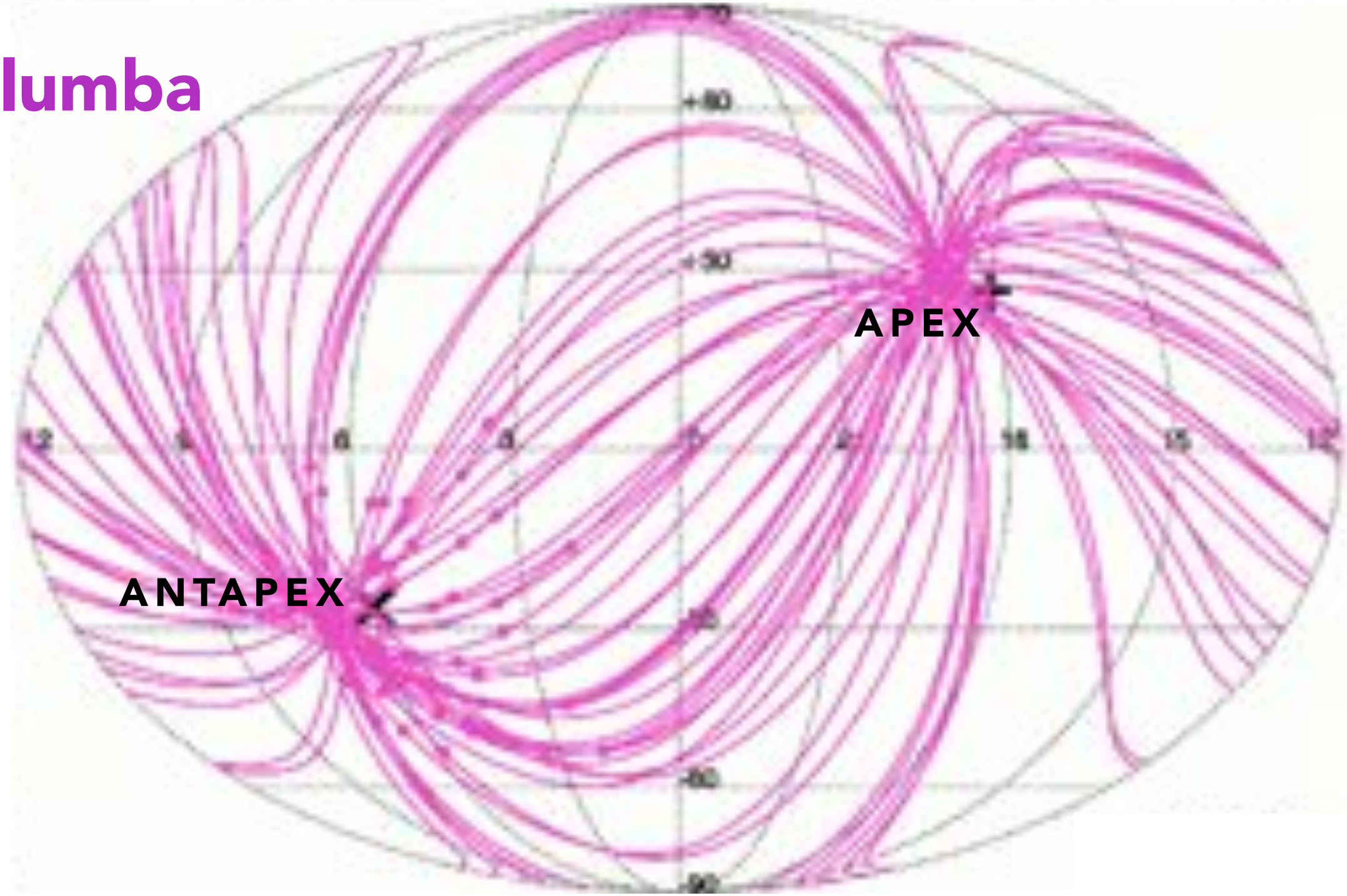
AB Dor



ADRIC RIEDEL (HUNTER COLLEGE/AMNH)

CONVERGENCE?

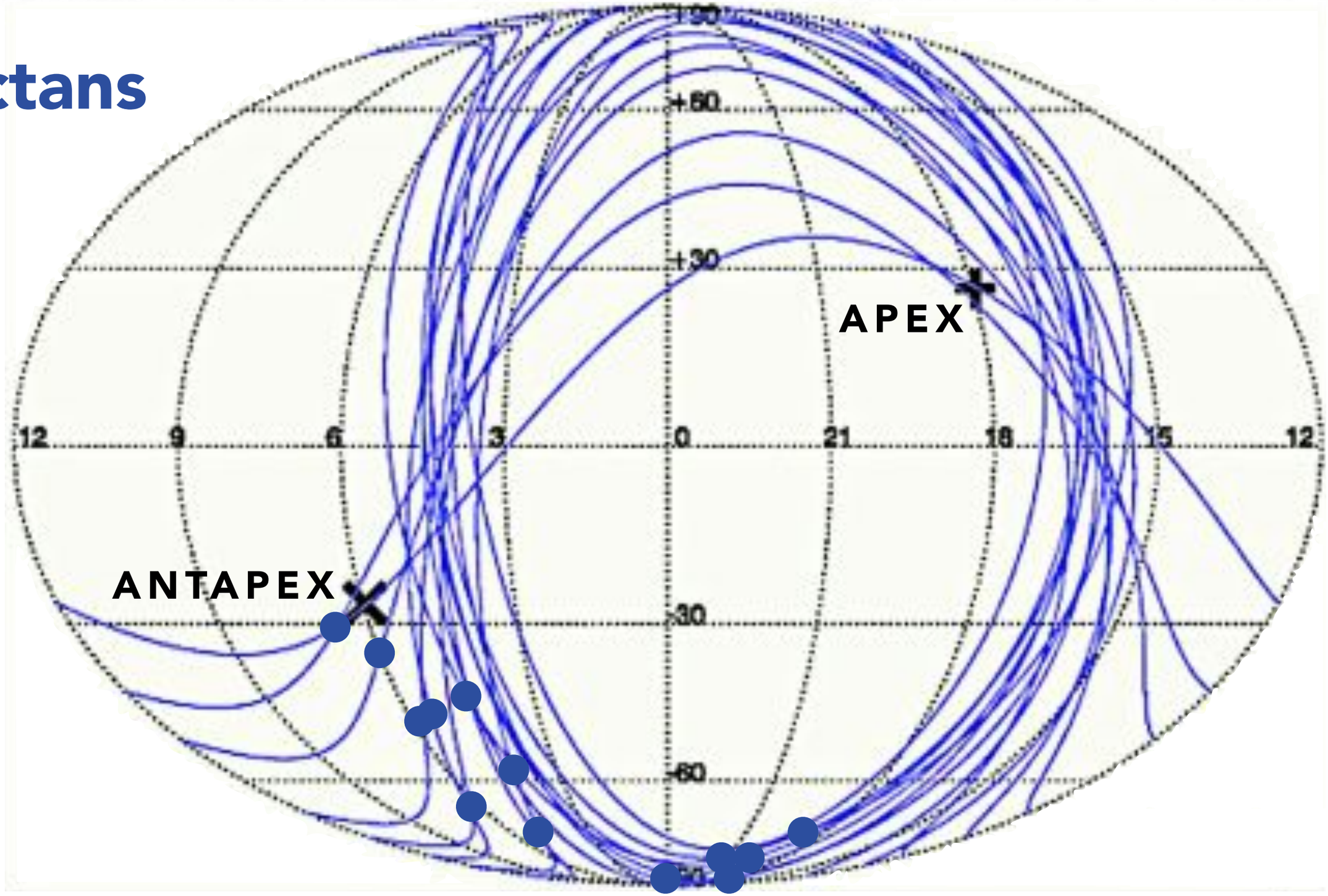
Columba



ADRIC RIEDEL (HUNTER COLLEGE/AMNH)

CONVERGENCE?

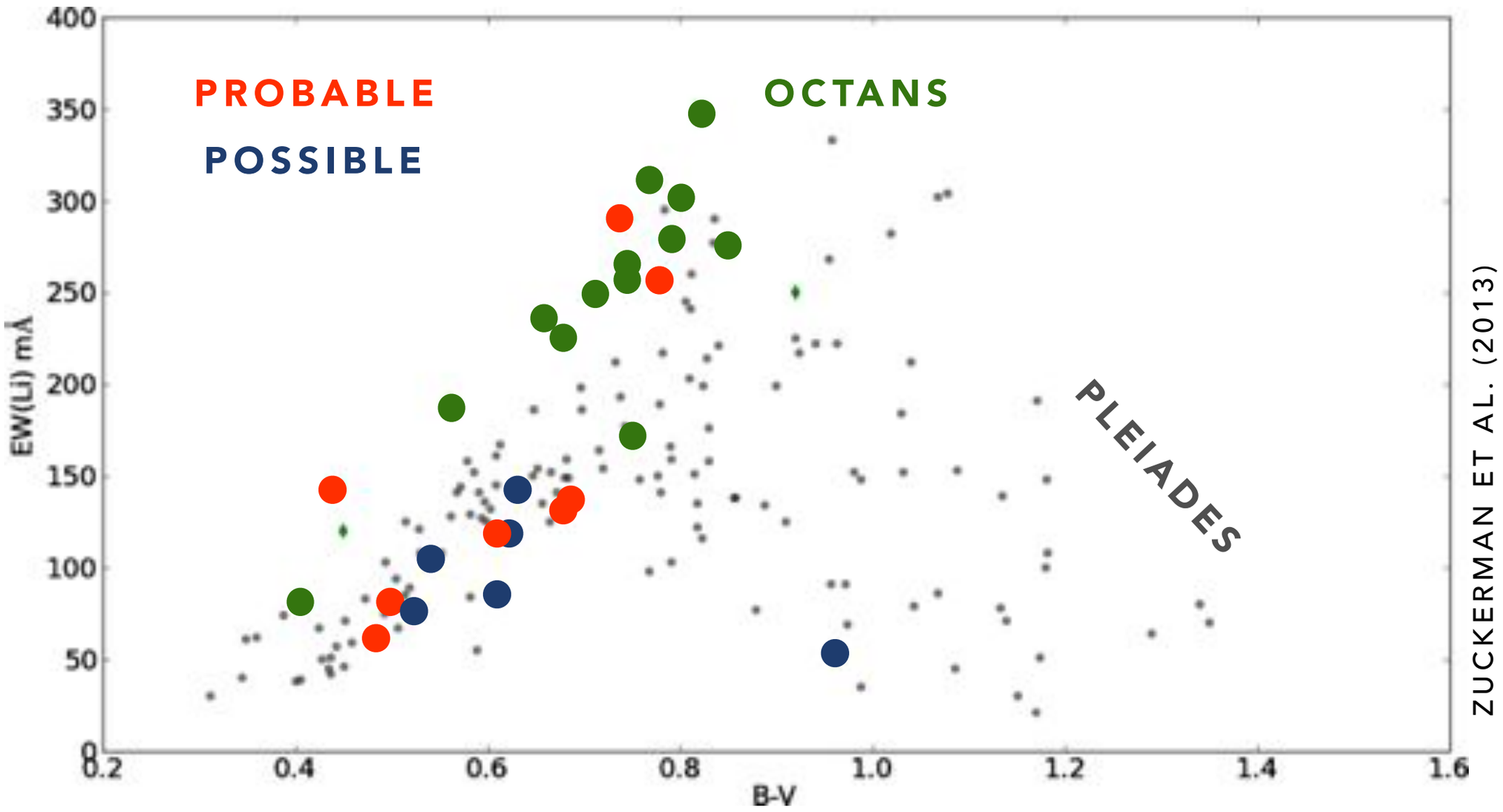
Octans



ADRIC RIEDEL (HUNTER COLLEGE/AMNH)

OCTANS-NEAR (ZUCKERMAN ET AL. 2013)

- 14 *Hipparcos* stars at **<100 pc** with Octans-like UVW
- Lithium and X-ray ages of **30-100 Myr**



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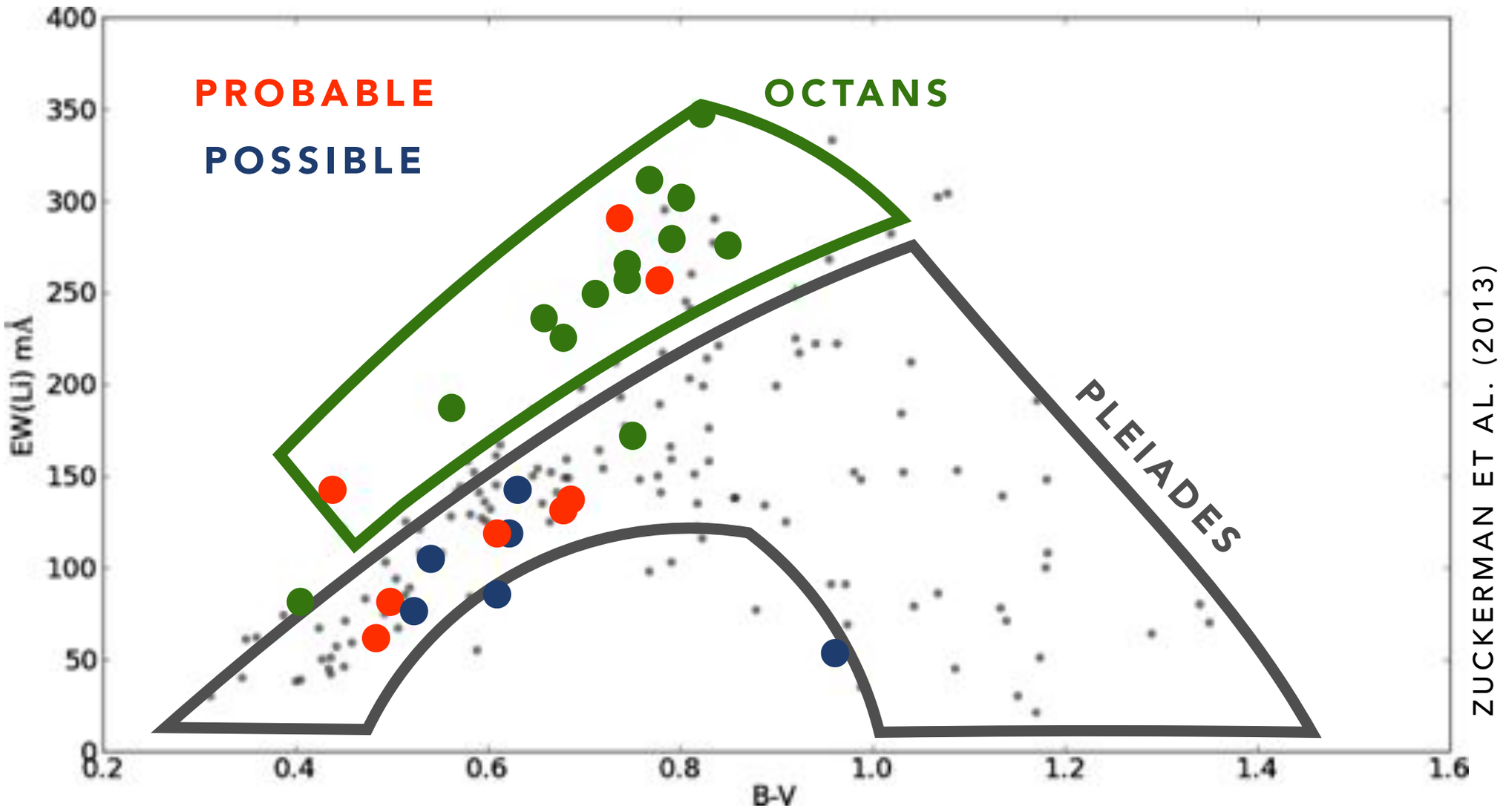
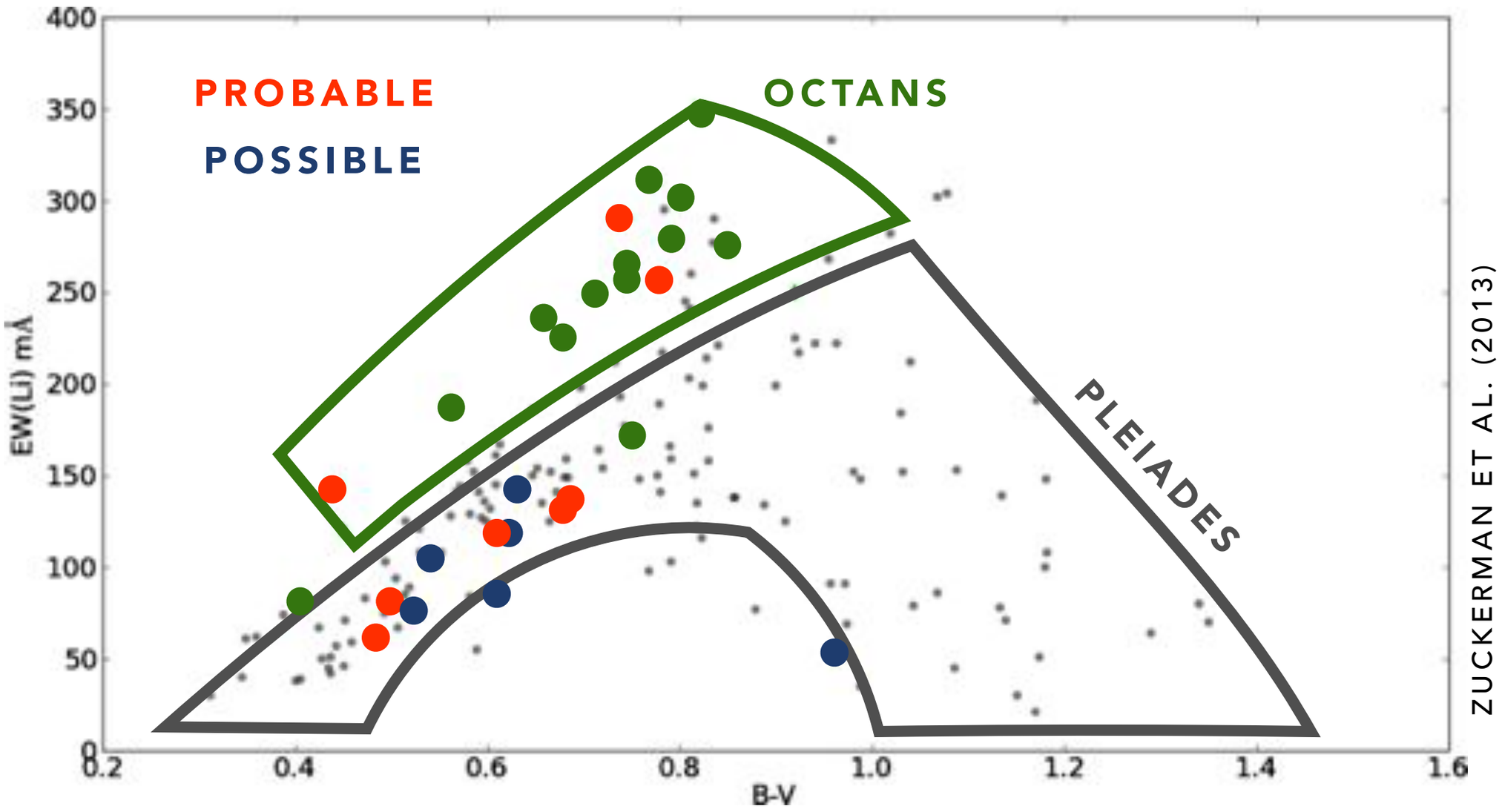


OCTANS-NEAR (ZUCKERMAN ET AL. 2013)

- **Does NOT appear co-eval**
- Connection to Octans unclear (SF complex, resonance?)



THE GOAL

IS OCTANS REAL AND WHAT IS ITS AGE?

- Expand membership to lower masses
- Break age/distance degeneracy using independent lithium depletion ages
    - Unlike solar type members, late K and M-type stars should lose their lithium in 10-100 Myr
- Expand membership spatially?

CANDIDATE SELECTION

CANDIDATE SELECTION

- SPM4 proper motions (δ<-20°, BV+JHK$_{2MASS}$)

100M OBJECTS

CANDIDATE SELECTION

- SPM4 proper motions (δ<-20°, BV+JHK$_{2MASS}$)

100M OBJECTS

- Colour and magnitude cuts to thin sample, remove reddened objects

5.4M OBJECTS

CANDIDATE SELECTION

- SPM4 proper motions (δ<-20°, BV+JHK$_{2MASS}$)

100M OBJECTS

- Colour and magnitude cuts to thin sample, remove reddened objects

5.4M OBJECTS

- **Kinematic selection over d_{kin}=[5,300] pc**
  - **$\sigma(\mu)$<5 mas/yr** and **$\Delta\mu_{Oct}$< 2$\sigma(\mu)$**

200K OBJECTS

CANDIDATE SELECTION

- SPM4 proper motions (δ<-20°, BV+JHK$_{2MASS}$)

  100M OBJECTS

- Colour and magnitude cuts to thin sample, remove reddened objects

  5.4M OBJECTS

- **Kinematic selection over d_{kin}=[5,300] pc**
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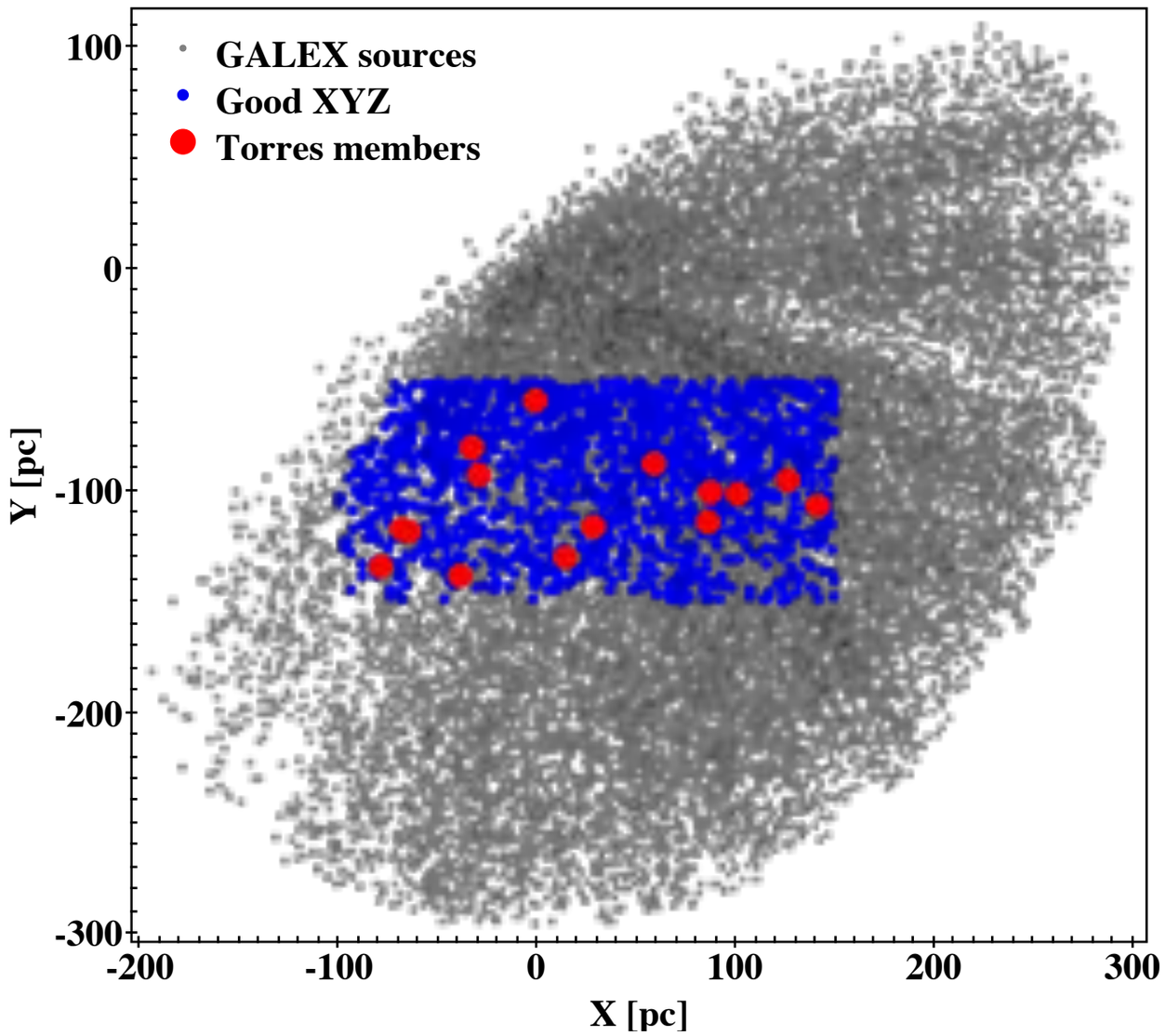
    200K OBJECTS

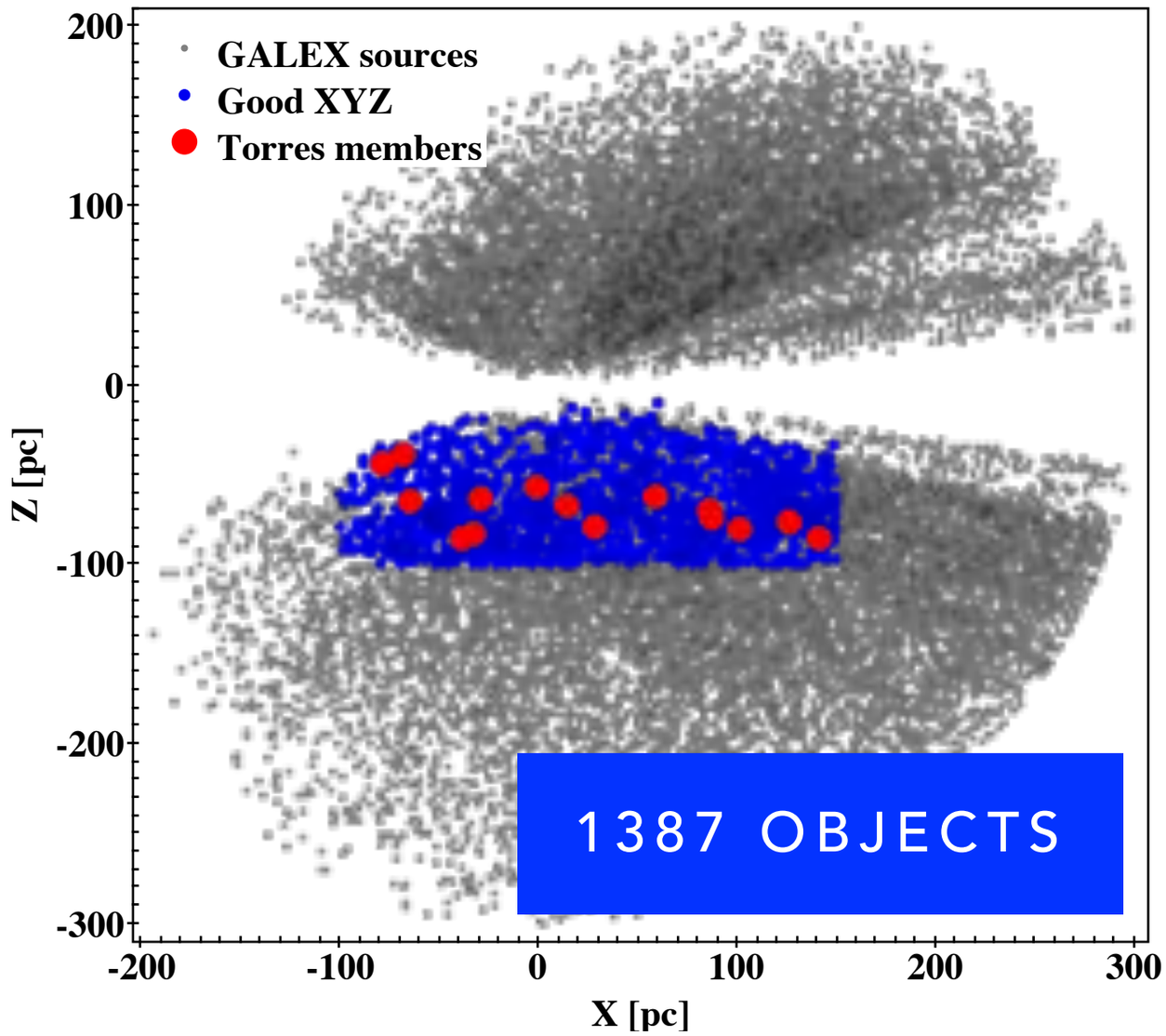
- X-Match against GALEX DR6 (avoids Galactic plane)

  25K OBJECTS

CANDIDATE SELECTION

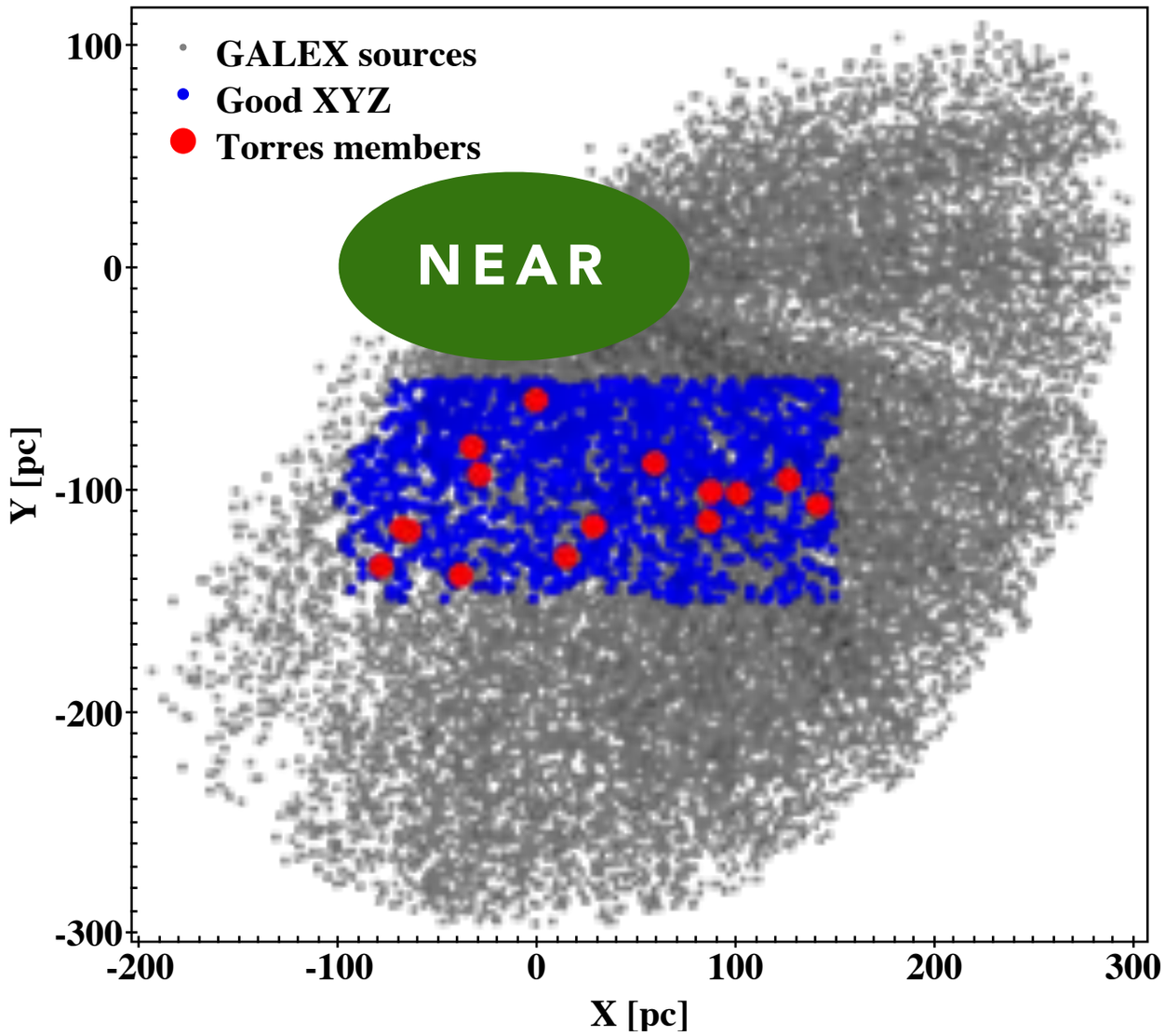
- Concentrate on region around existing membership

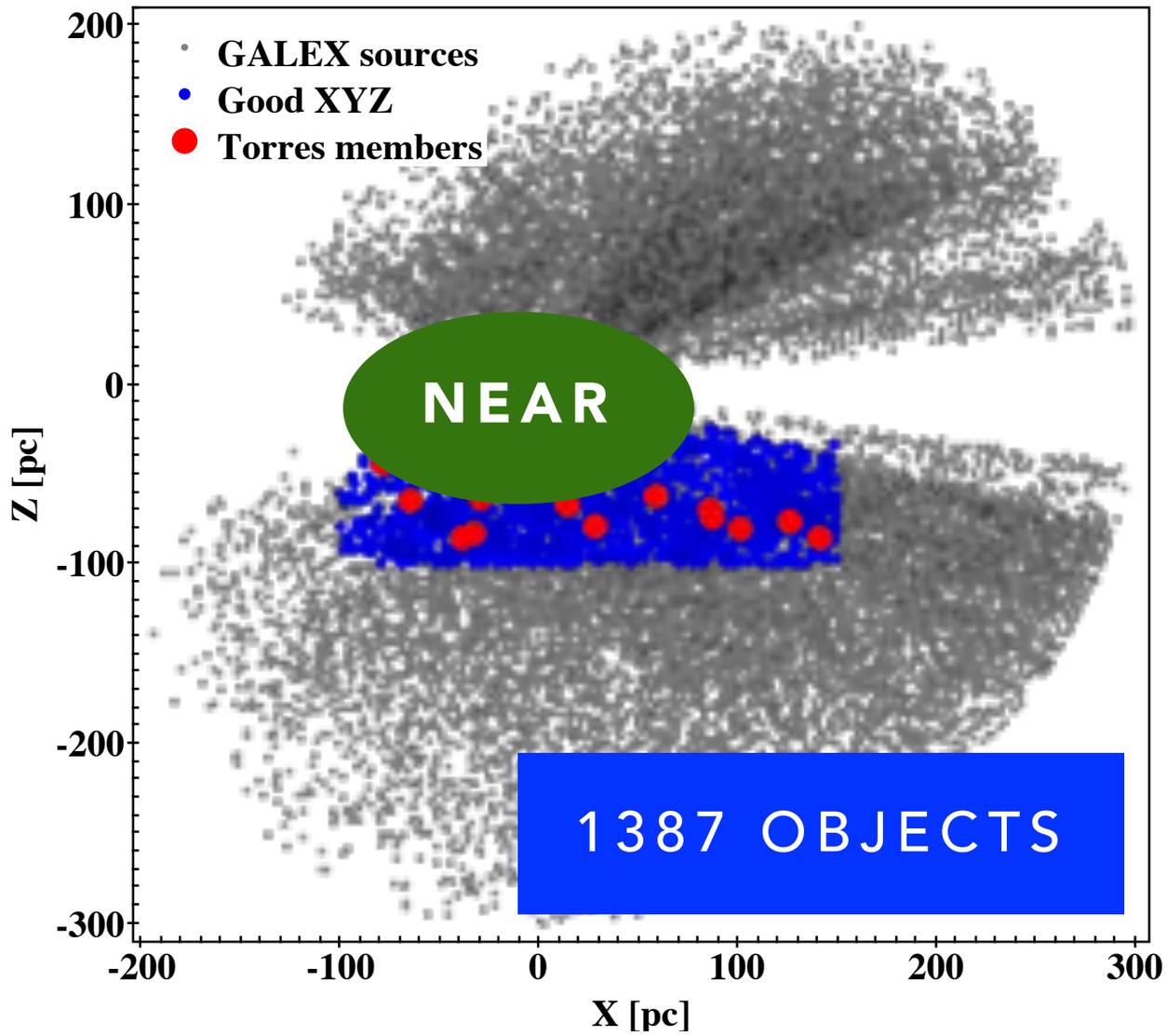




CANDIDATE SELECTION

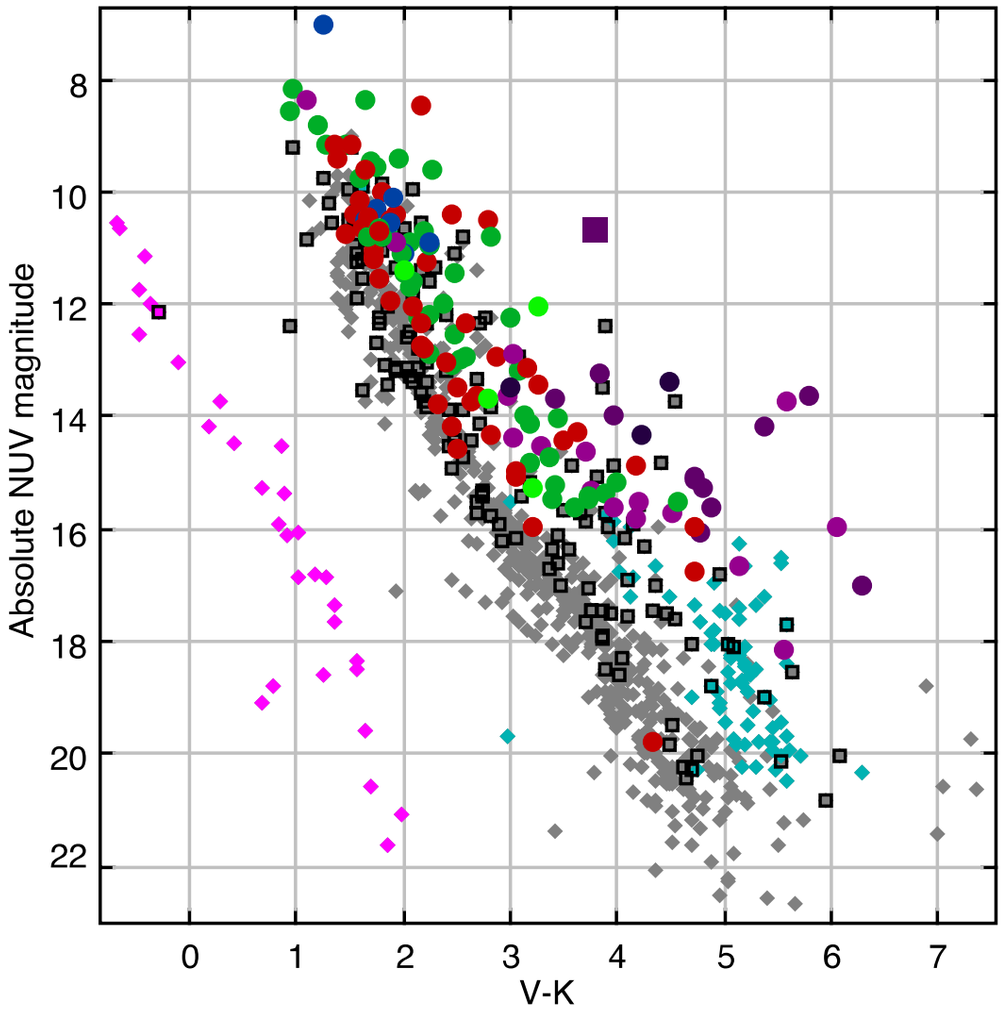
- Concentrate on region around existing membership

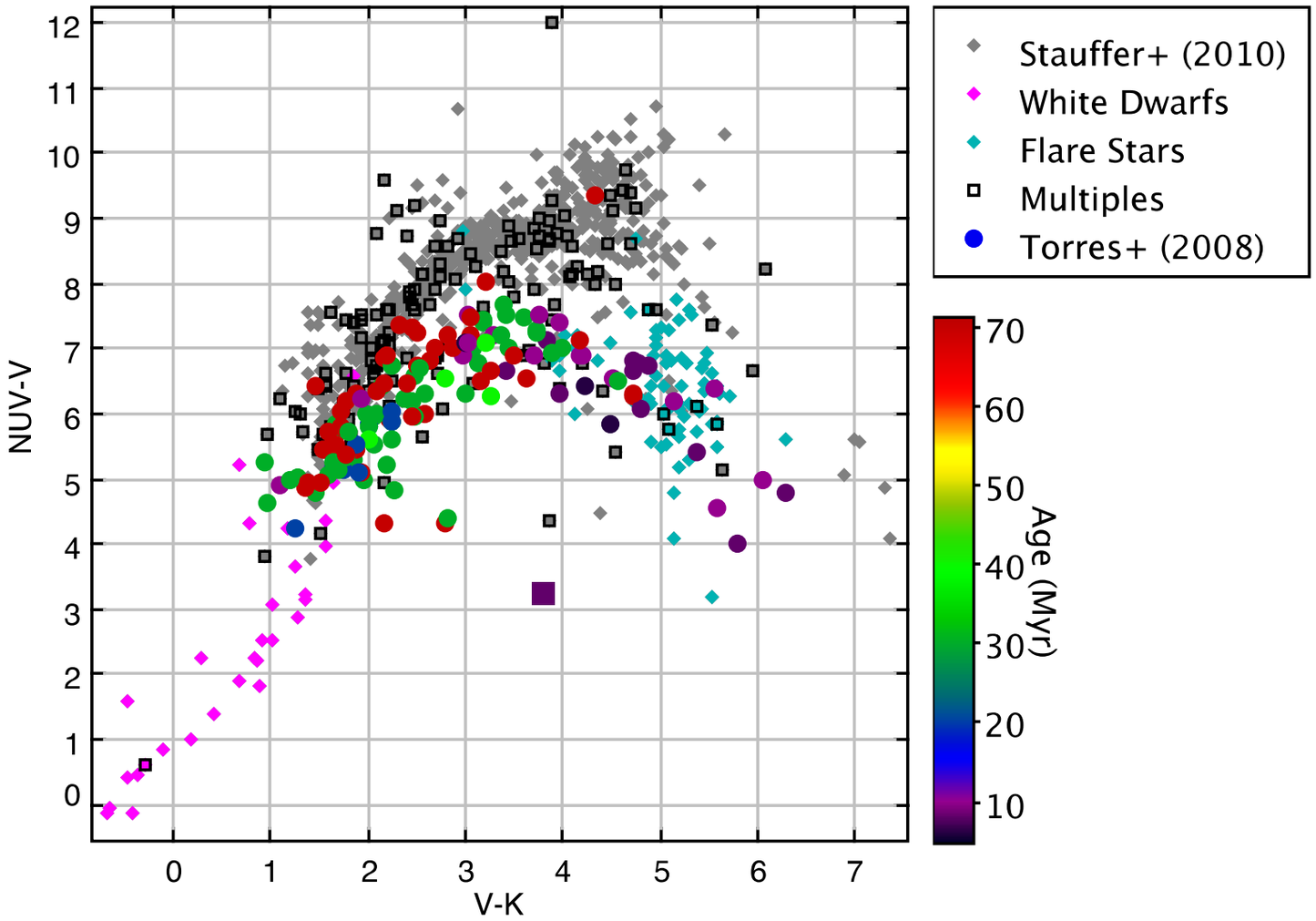




CANDIDATE SELECTION

- GALEX near-UV selection (after Rodriguez et al. 2011)





RODRIGUEZ ET AL. (2011)

CANDIDATE SELECTION

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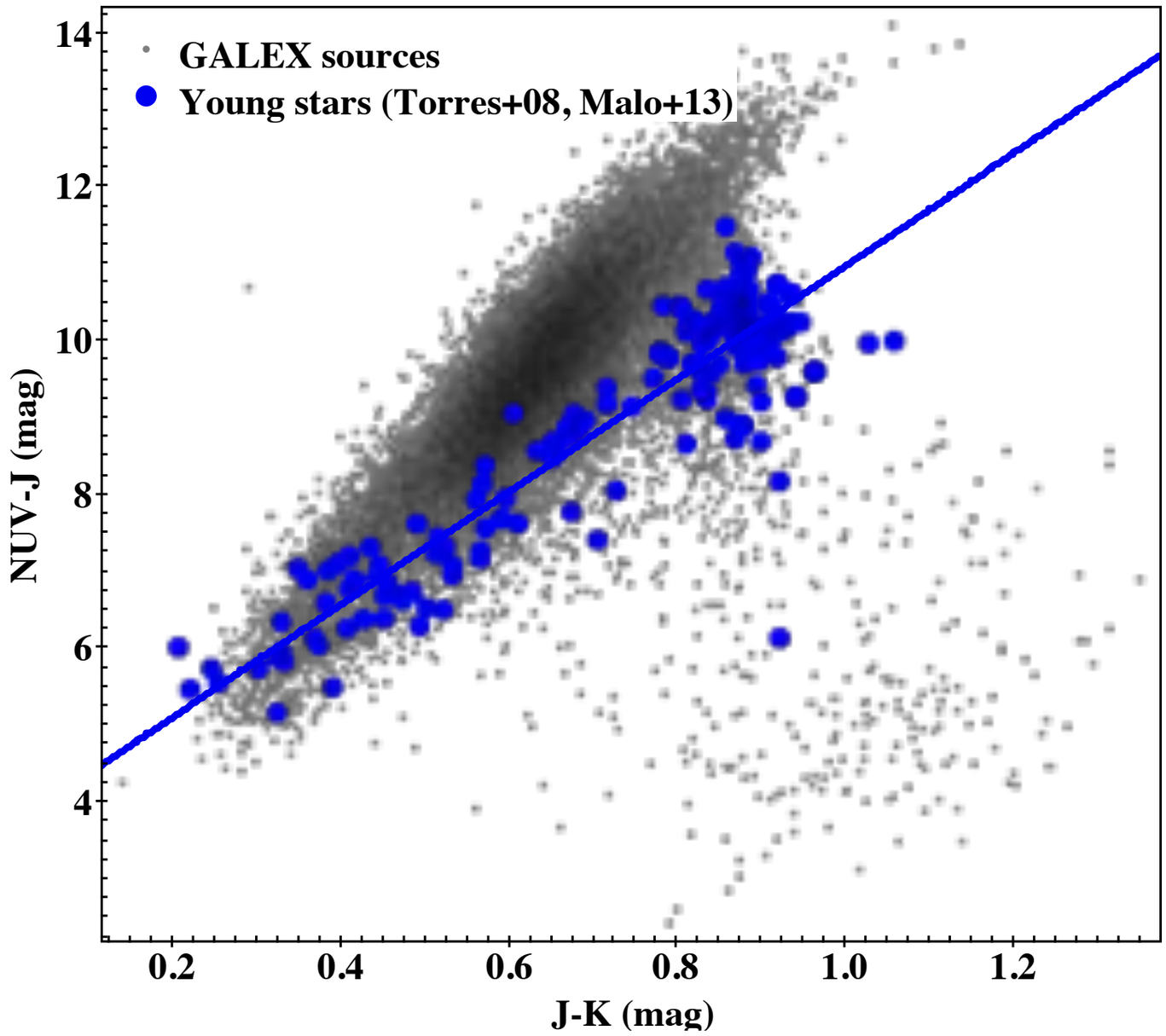

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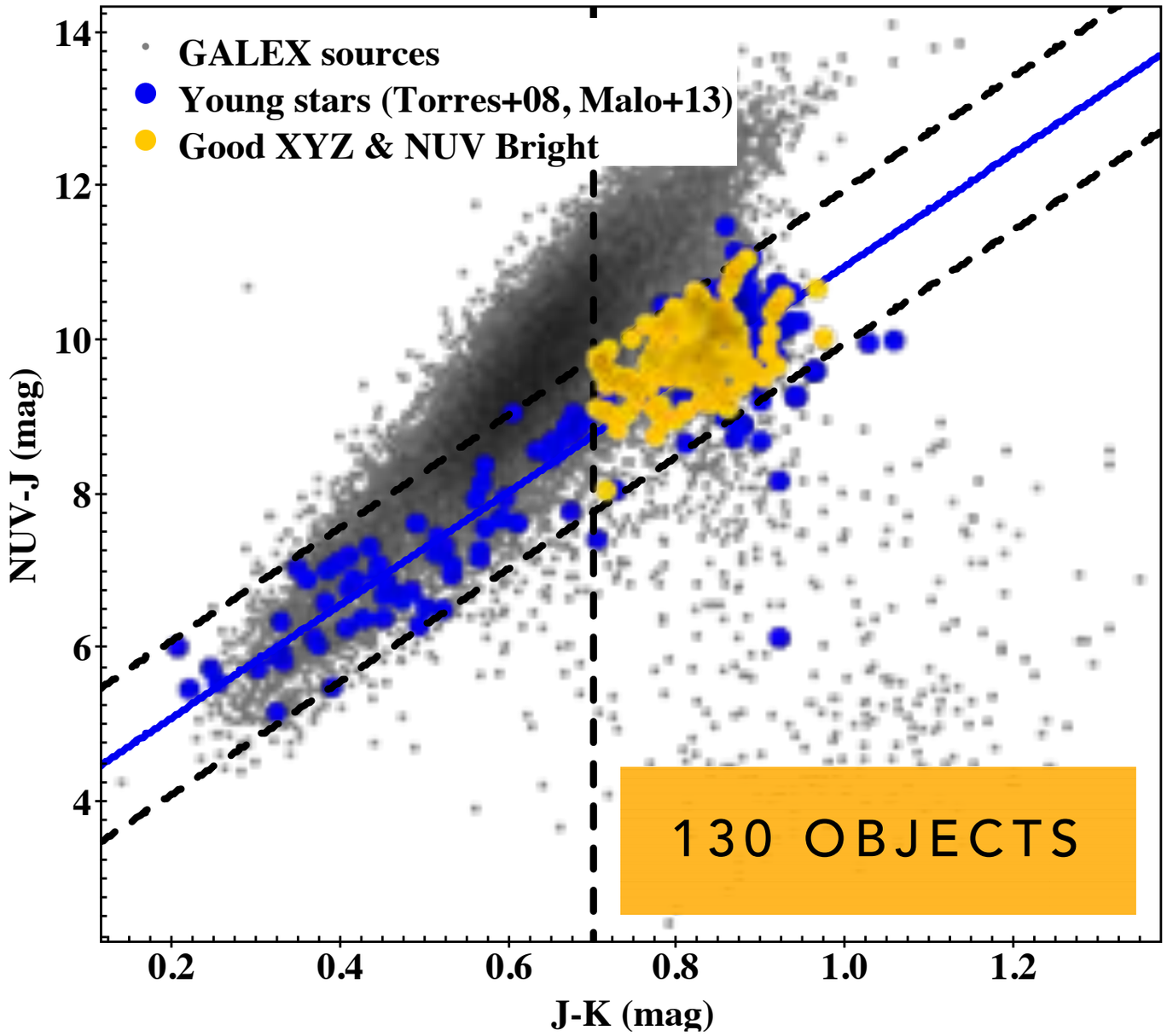

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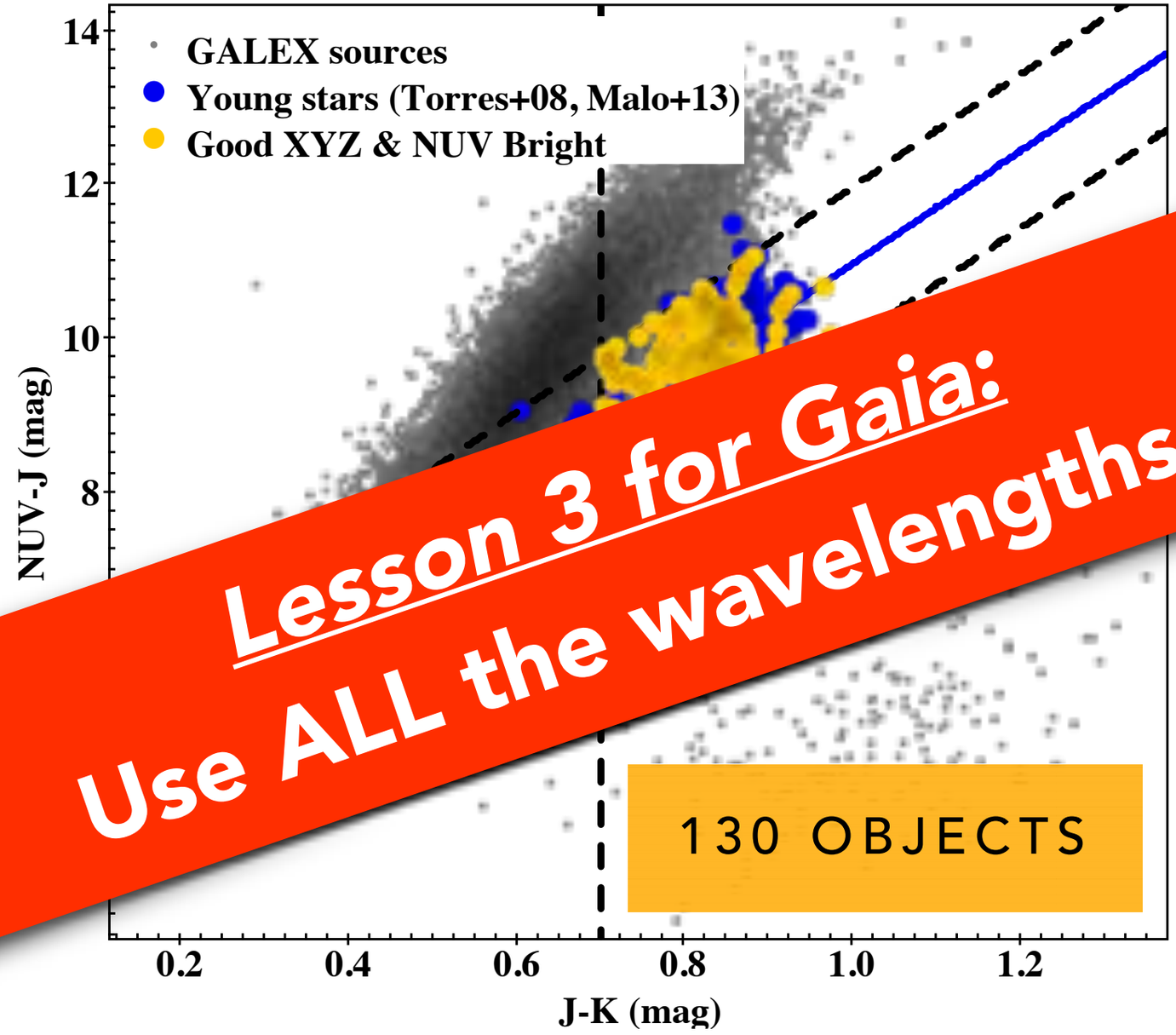
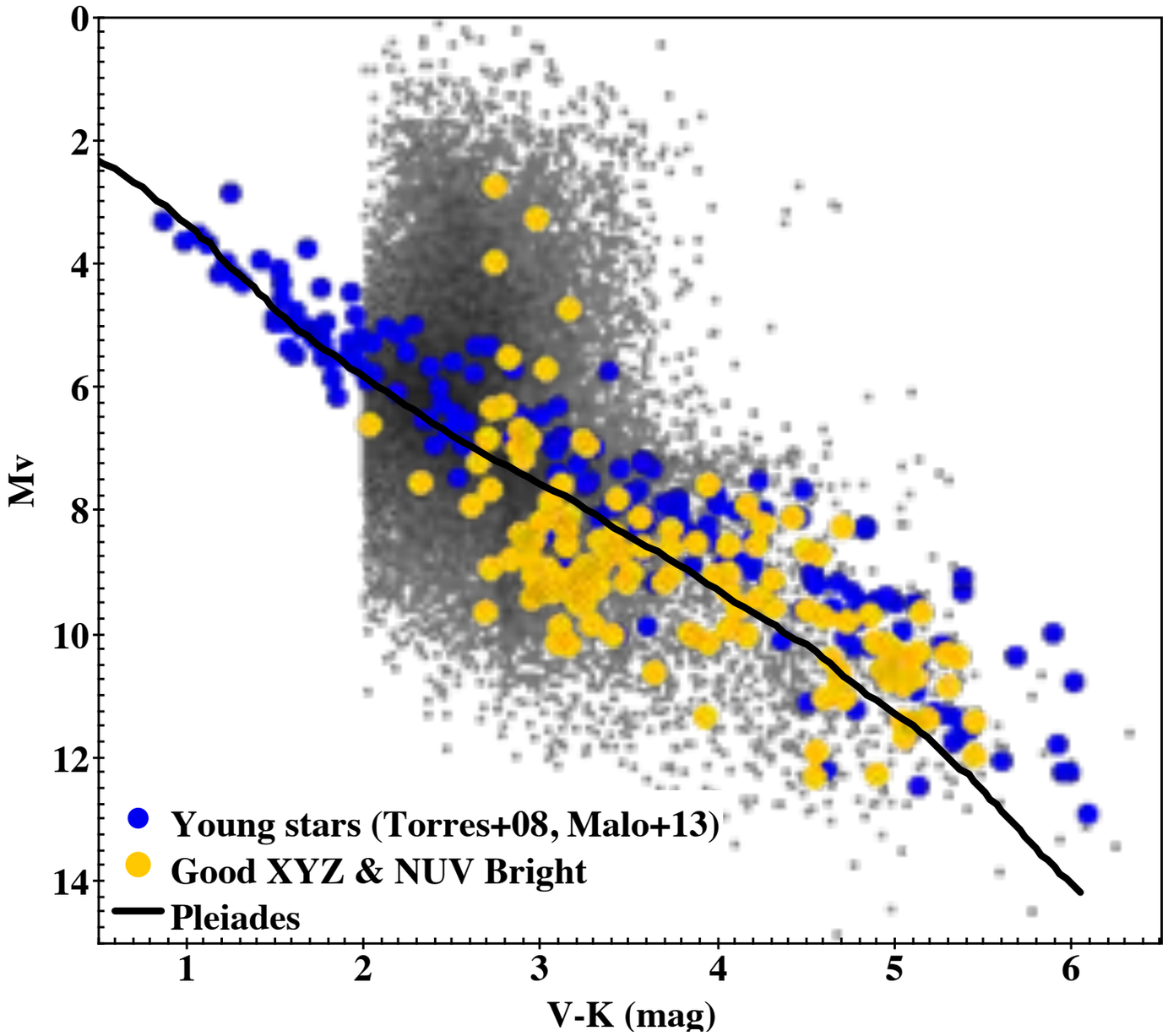


Lesson 3 for Gaia:
Use ALL the wavelengths!

CANDIDATE SELECTION

- Fold together photometric and kinematic distances



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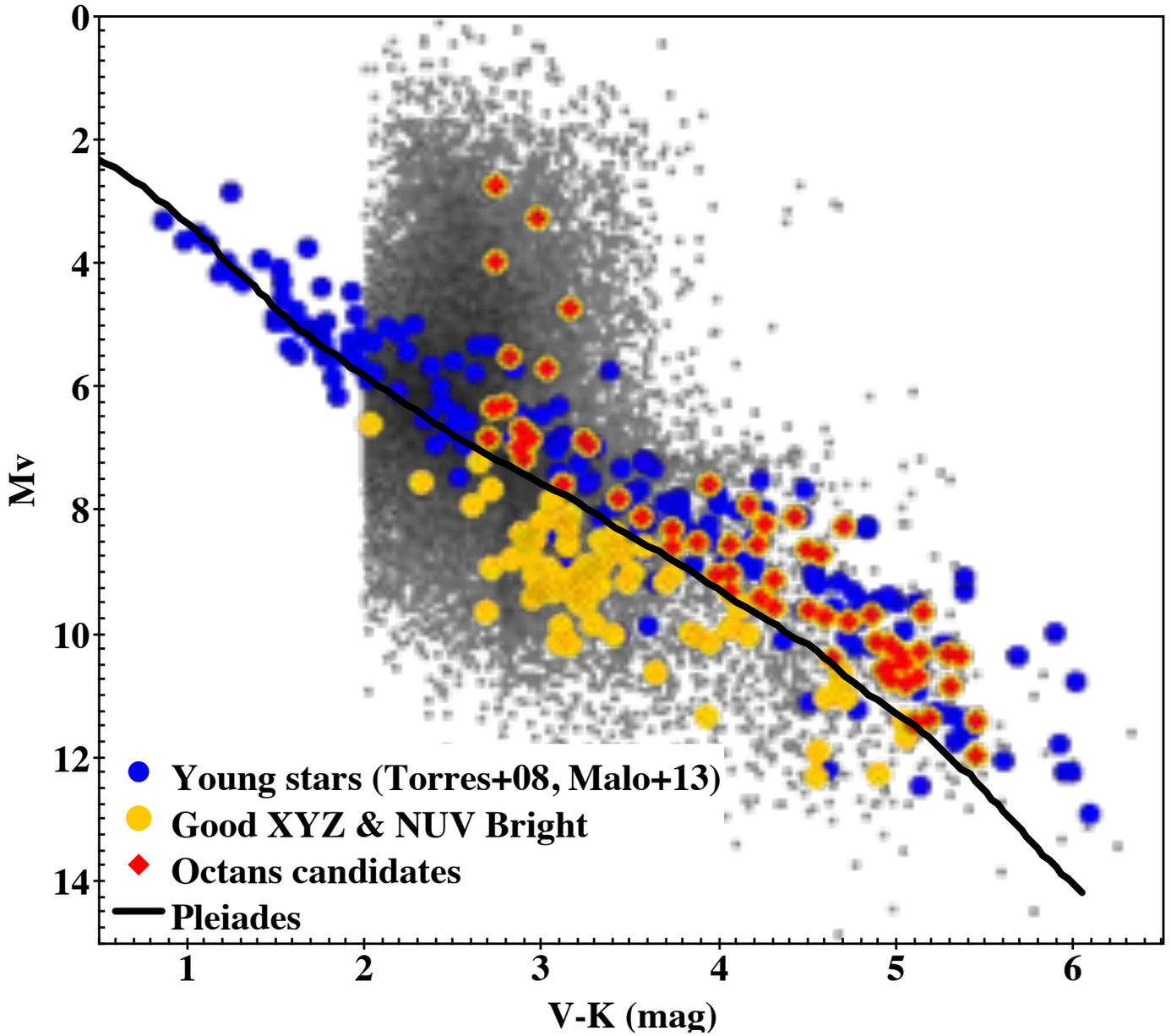
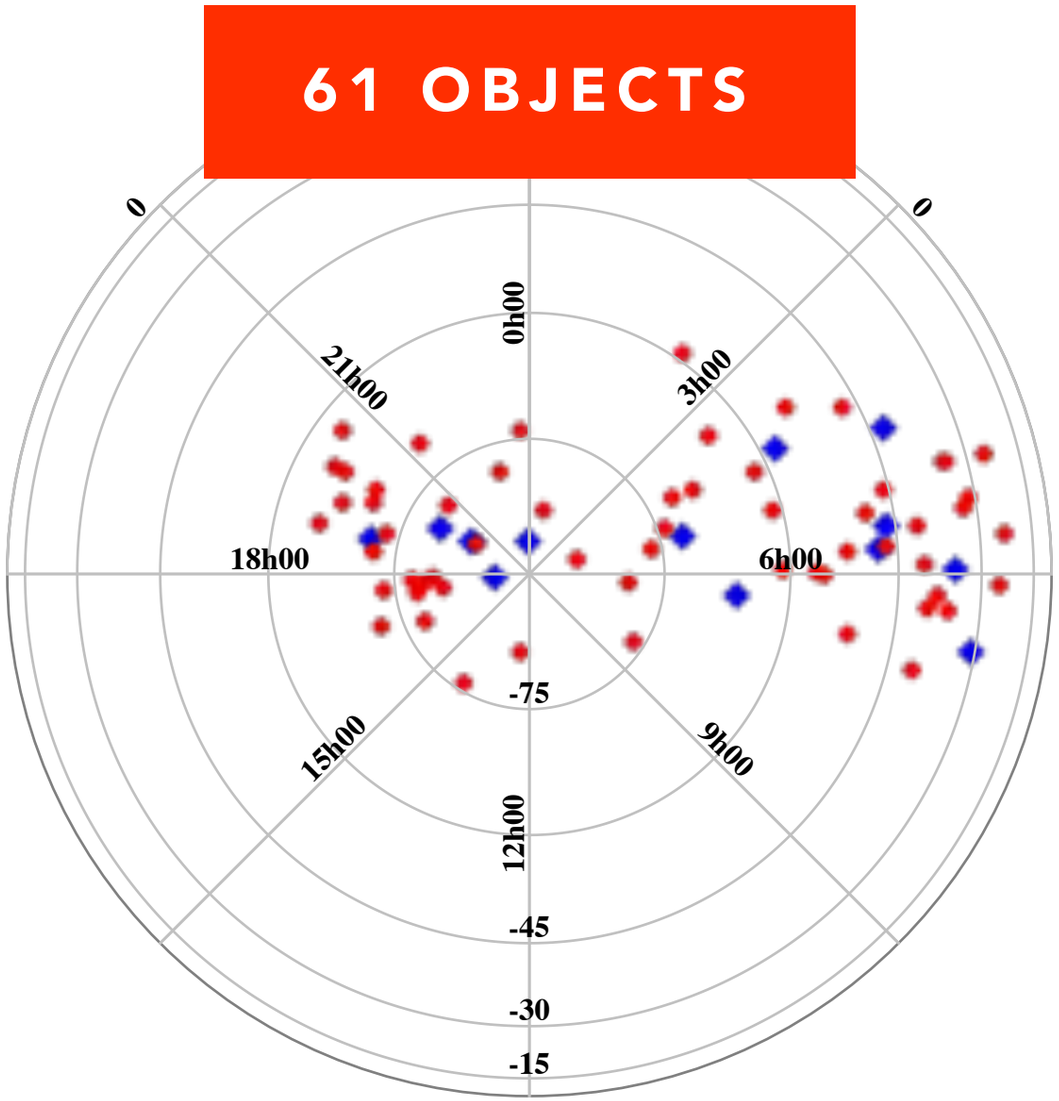


61 OBJECTS



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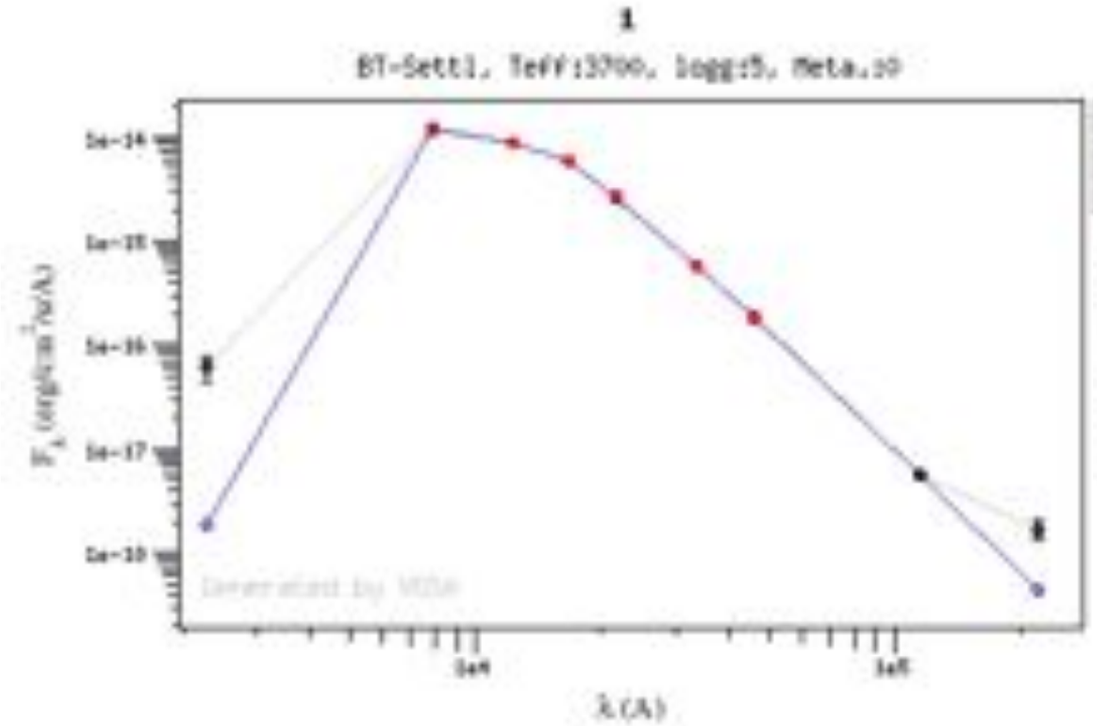
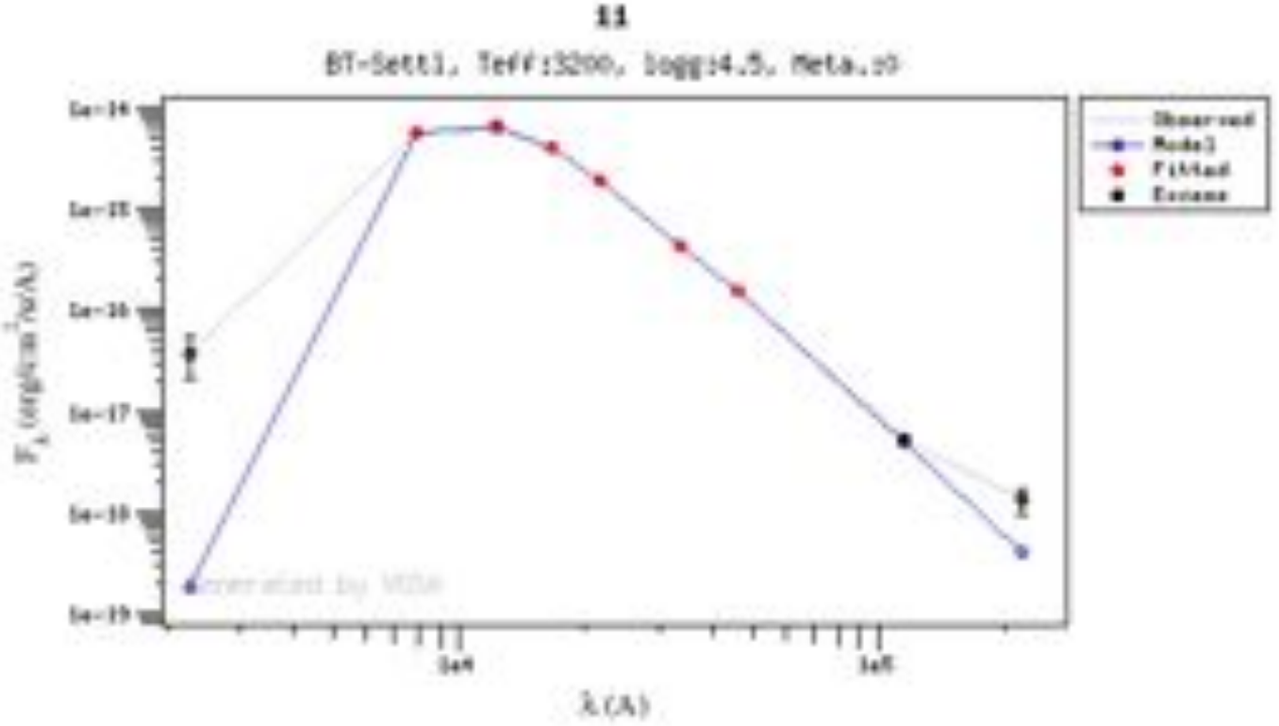
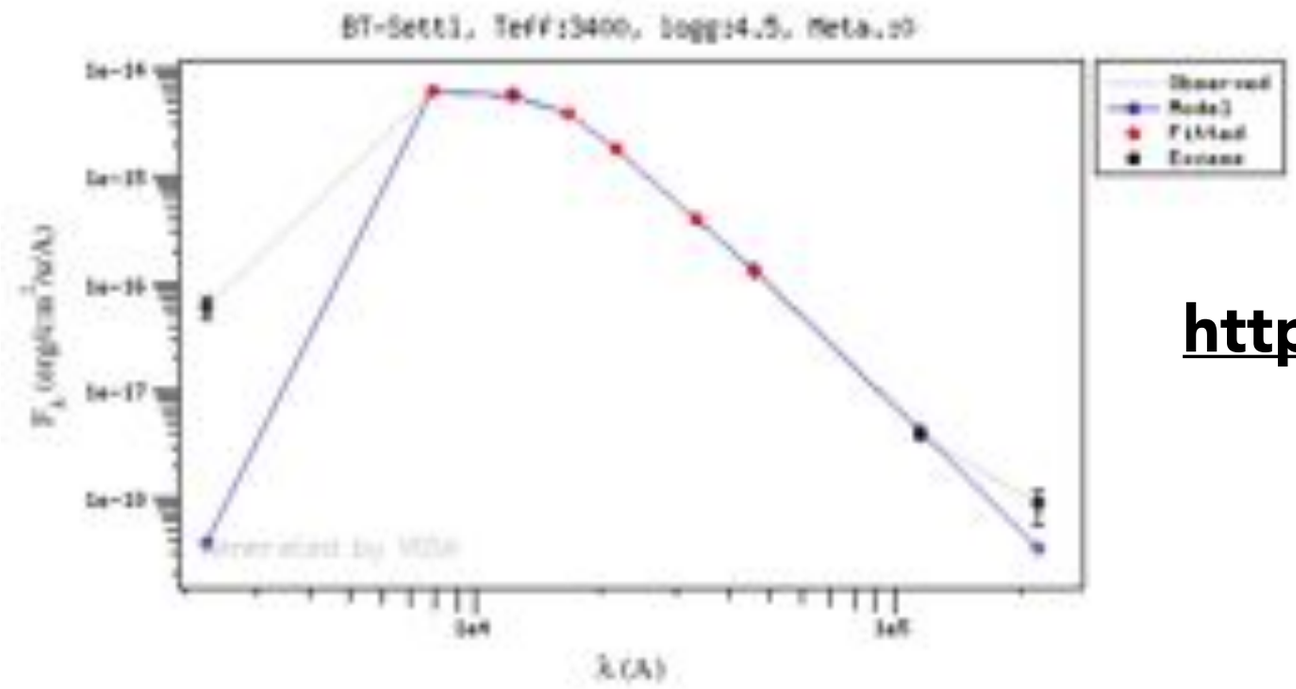
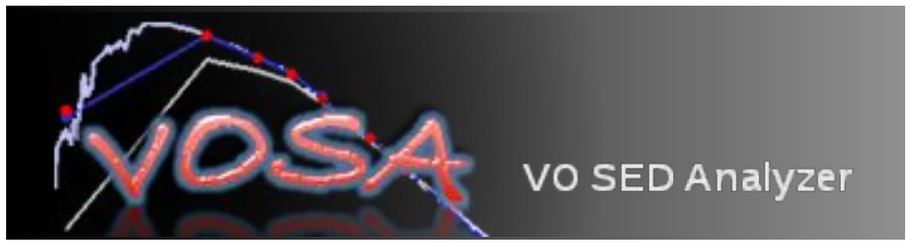






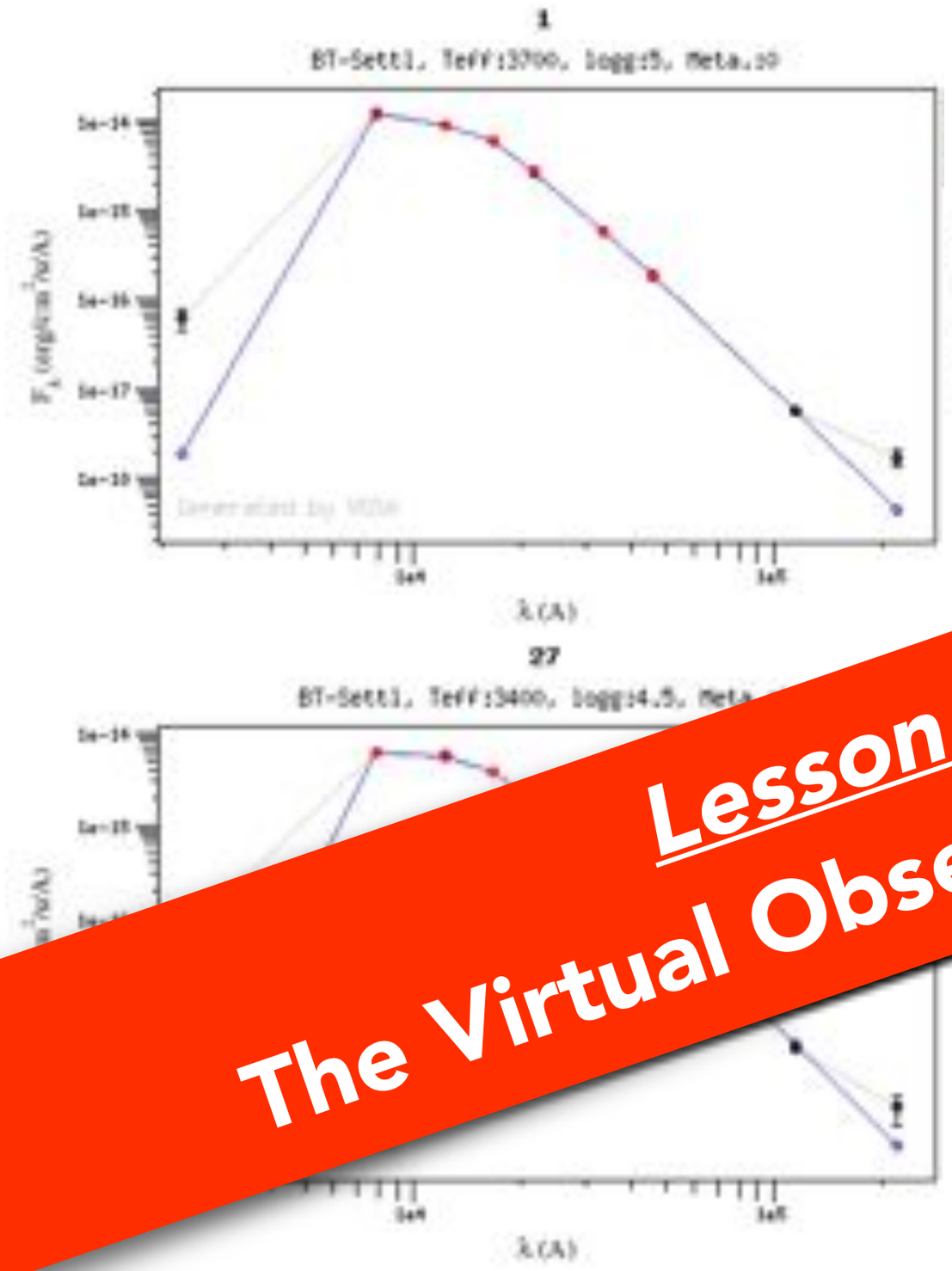


http://svo2.cab.inta-csic.es/theory/vosa/

+ A. Bayo poster

More VO tomorrow…

CANDIDATE SELECTION



Lesson 4 for Gaia:

The Virtual Observatory is your friend

VOSA VO SED Analyzer

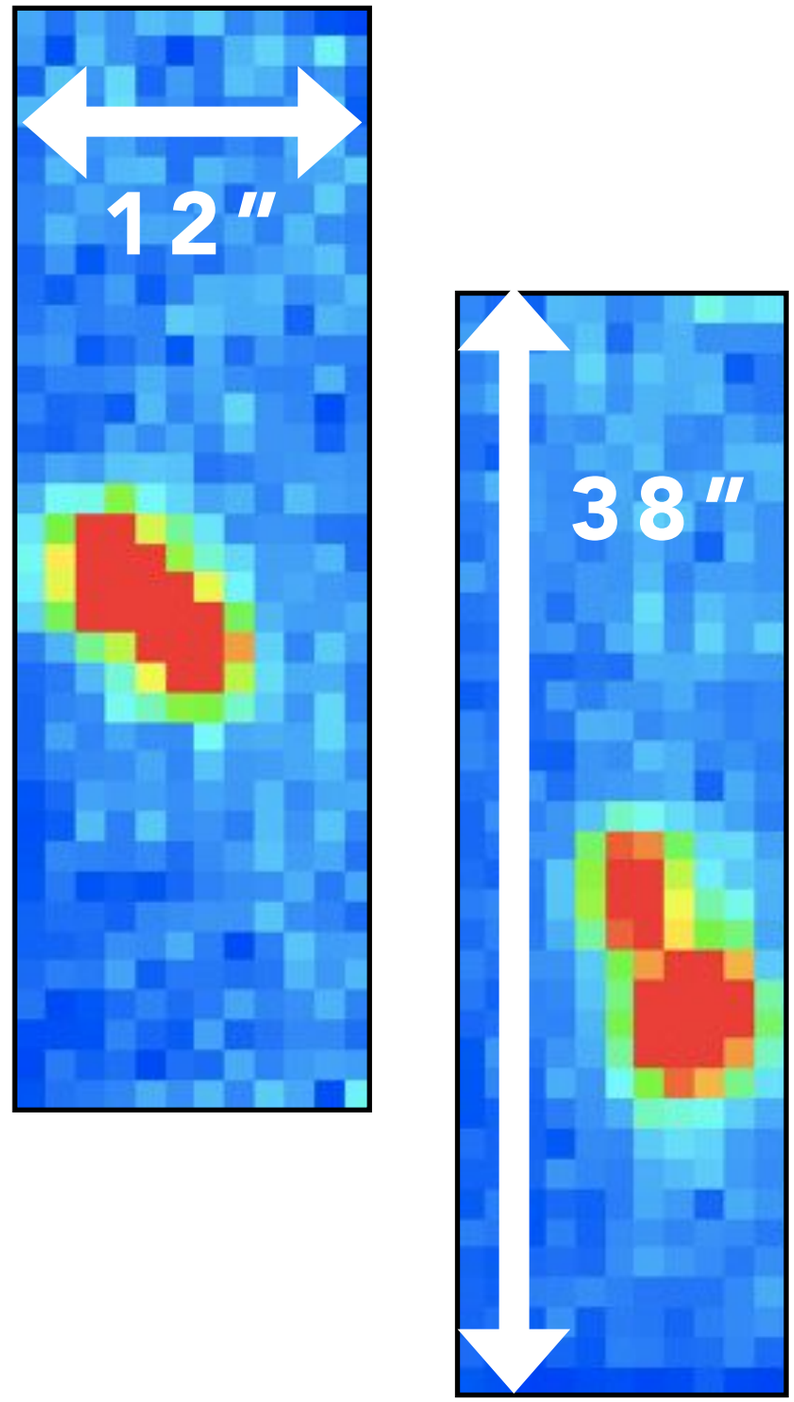
http://svo2.cab.inta-csic.es/theory/vosa/

+ A. Bayo poster

More VO tomorrow…

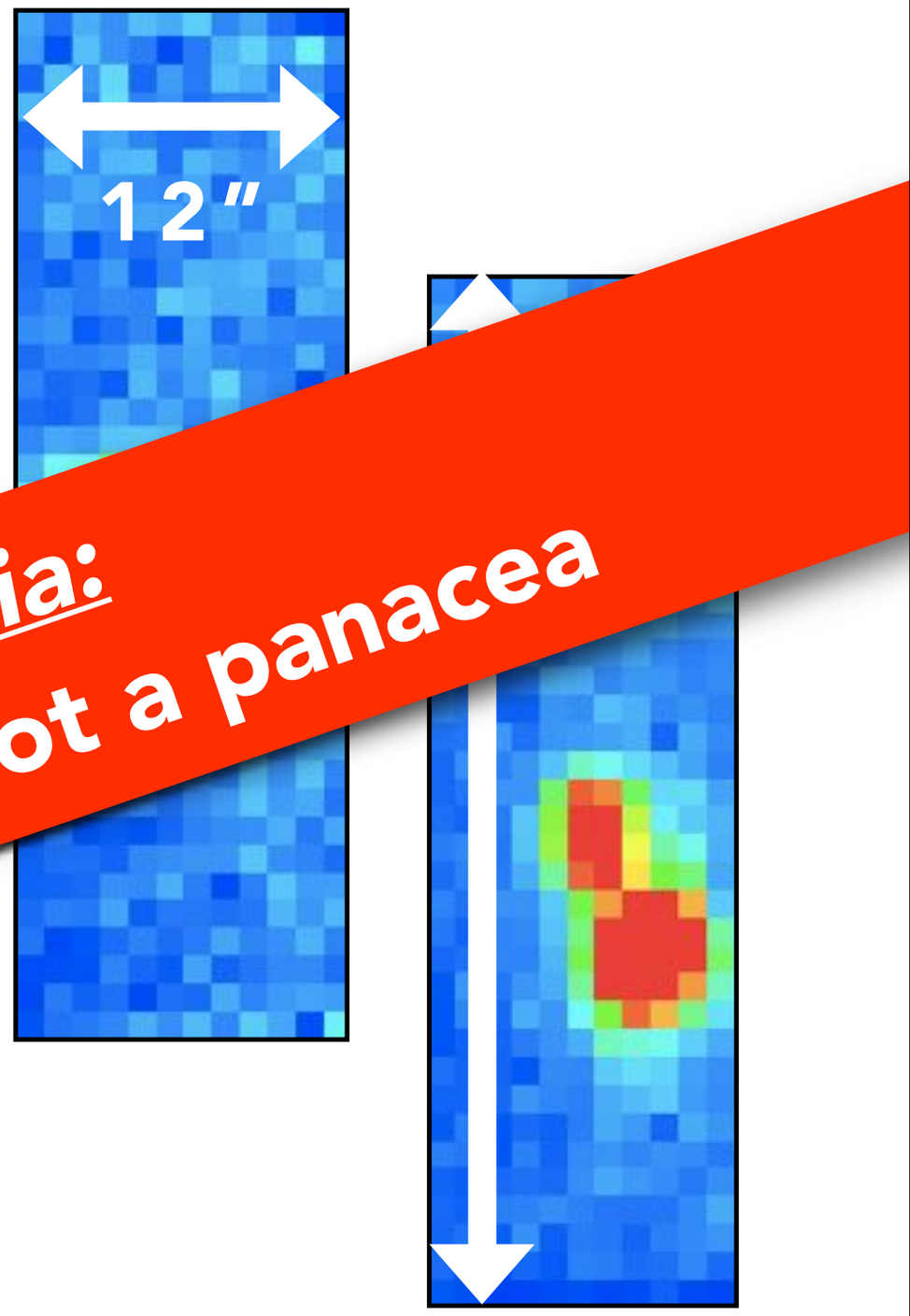
SPECTROSCOPIC FOLLOW-UP

- *R*=7000 spectroscopy on SSO ANU 2.3-m/WiFeS
- Image-slicing 25x38″ IFU
- 5300-7000 Å (Hα + Li λ6708)
- RVs to 1-2 km/s
- 34 targets in 2014 Jan, another run in May



SPECTROSCOPIC FOLLOW-UP

- *R*=7000 spectroscopy on SSO ANU 2.3-m/WiFeS
- Image-slicing 25x38″ IFU
- 5300-7000 Å (Hα + Li λ670
- RVs to 1-2 k
- May

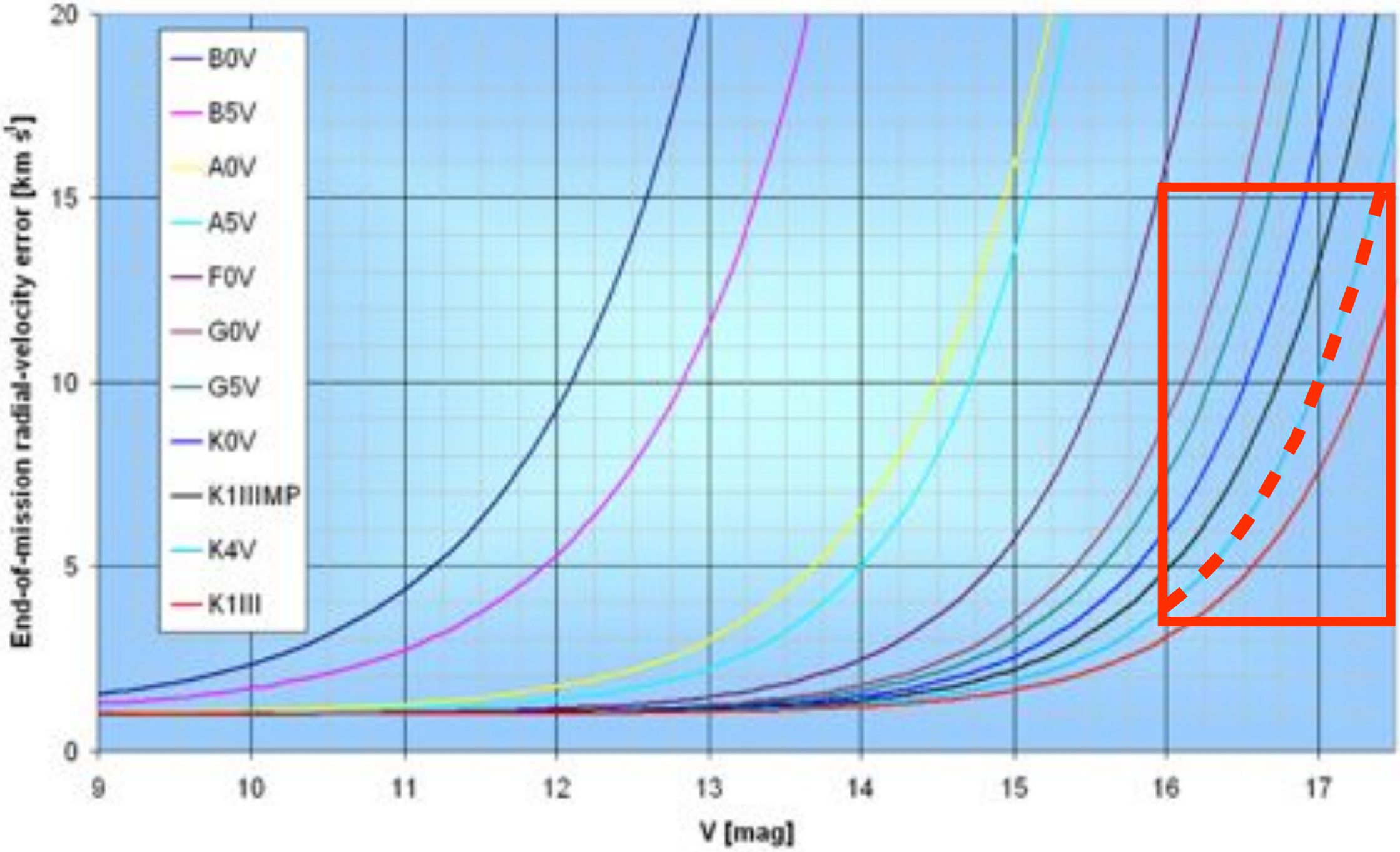


Lesson 5 for Gaia:
Hard medicine: Gaia is not a panacea

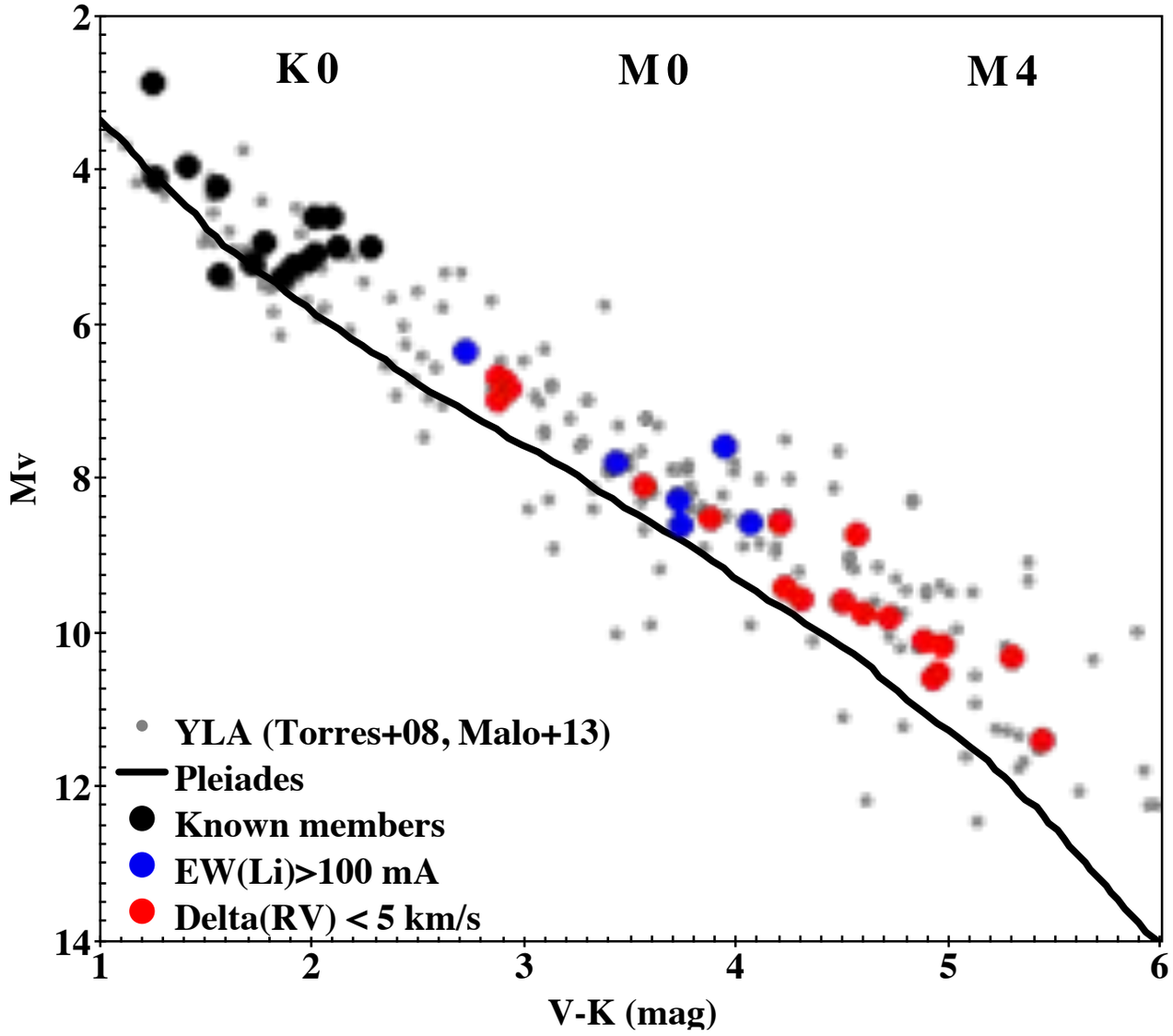
SPECTROSCOPIC FOLLOW-UP

GAIA SKY AVERAGED END OF MISSION PERFORMANCE

http://www.cosmos.esa.int/web/gaia/science-performance

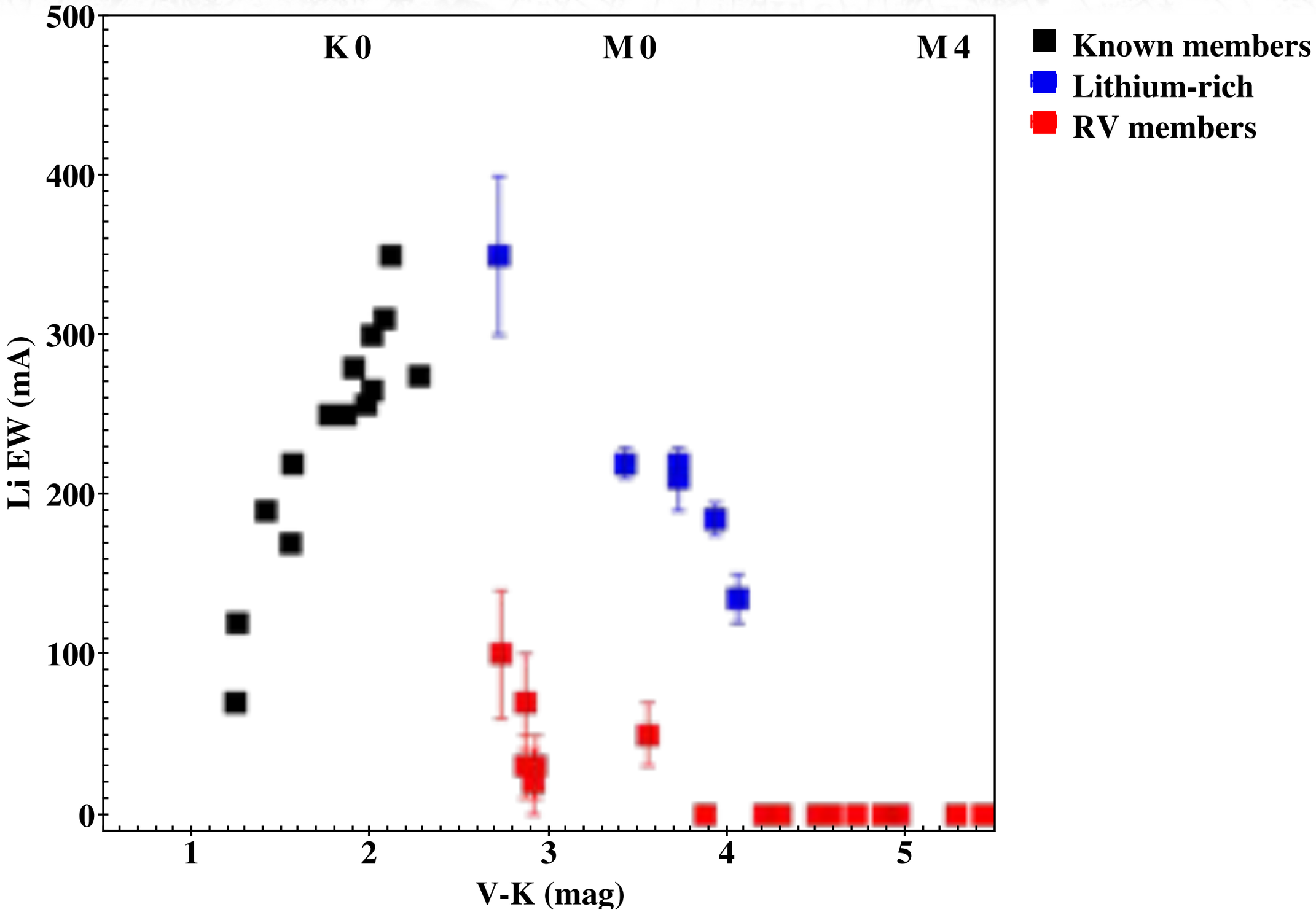


PRELIMINARY RESULTS

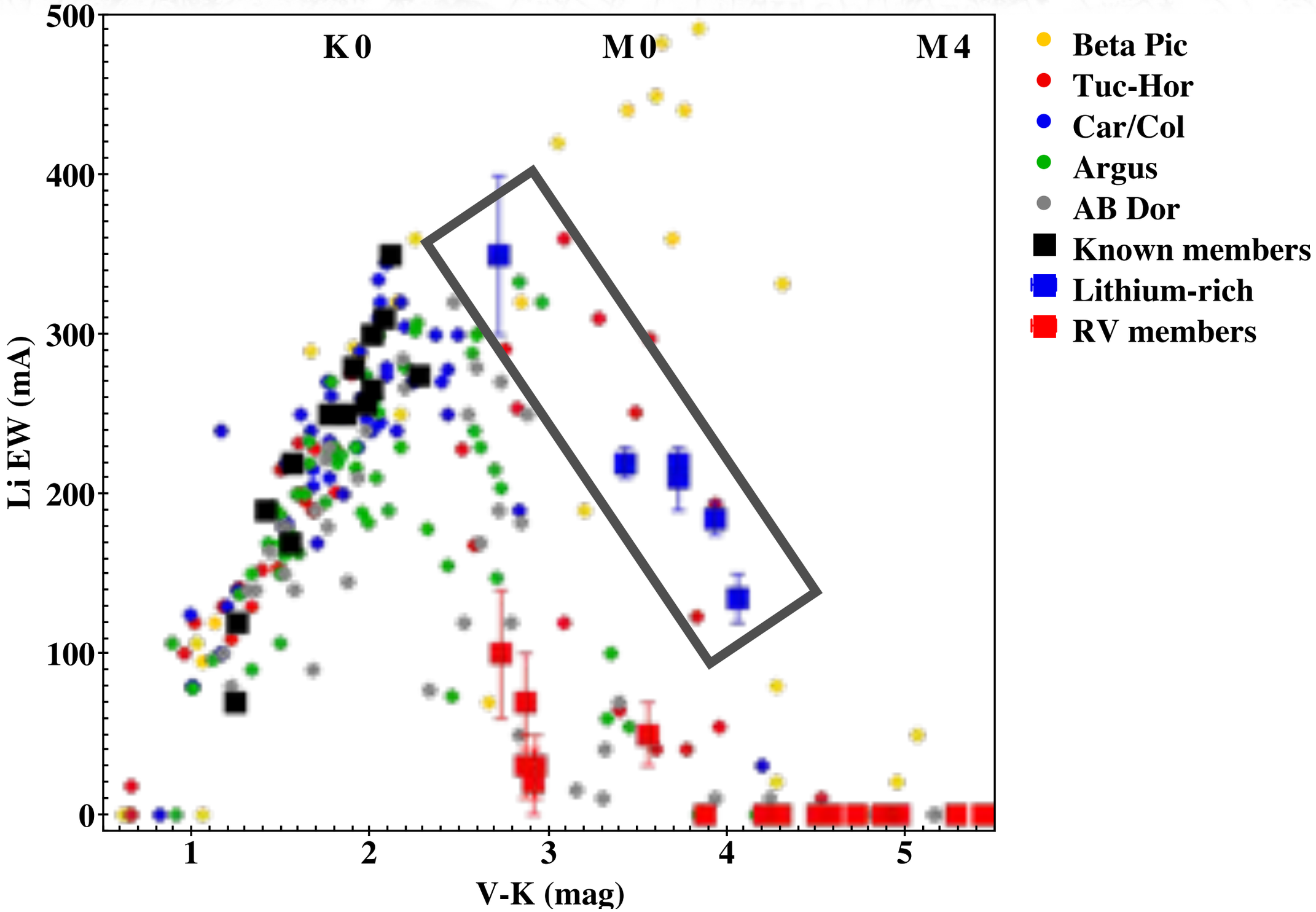


- 24 stars with RVs within 5 km/s of expected
- Including **6 stars with EW(Li)>100 mA**
- Several suspected spectroscopic binaries, and/or fast rotators
- *WISE* 22μm disk excesses, *ROSAT* detections

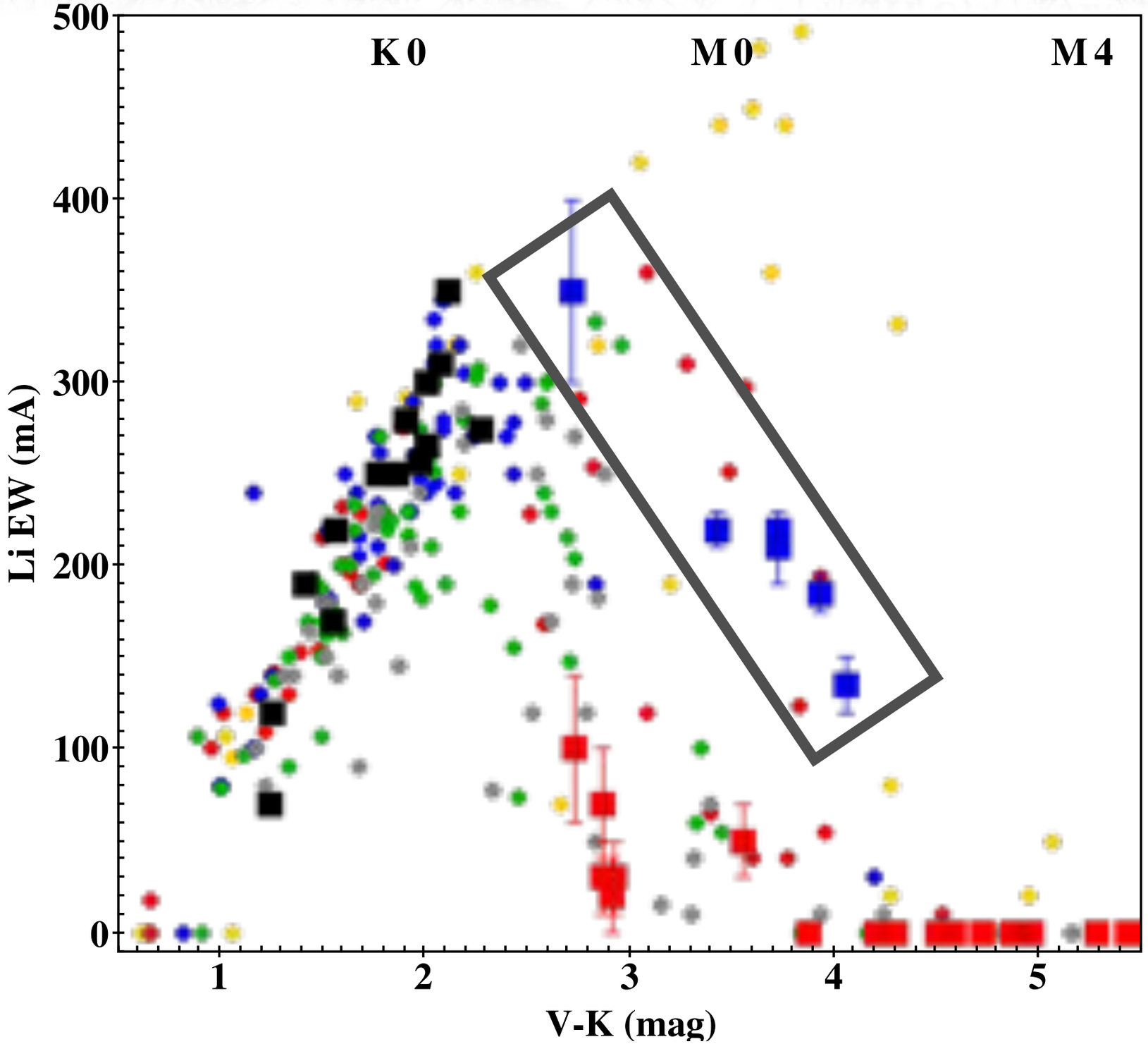
PRELIMINARY RESULTS



PRELIMINARY RESULTS



PRELIMINARY RESULTS



Li EWs between β Pic (20 Myr) and Argus/IC 2301 (50 Myr), similar to Tuc-Hor

AGE ~30 MYR?

SUMMARY & OUTLOOK

- First low-mass membership of Octans
- Association *appears** to be **real** and **~30 Myr old**

  *** DOES THIS SATISFY THE 'MAMAJEK CRITERIA'?**
- Origin and relationship to Octans-Near still unclear
- More M-type members needed
  - LDB at spectral type M4/5?
- ***Gaia* will revolutionise young ~~nearby~~ associations across stellar mass**

FROM THIS…

SUMMARY & OUTLOOK

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