Debris Disks and SPICA Uncovering Kuiper Belts

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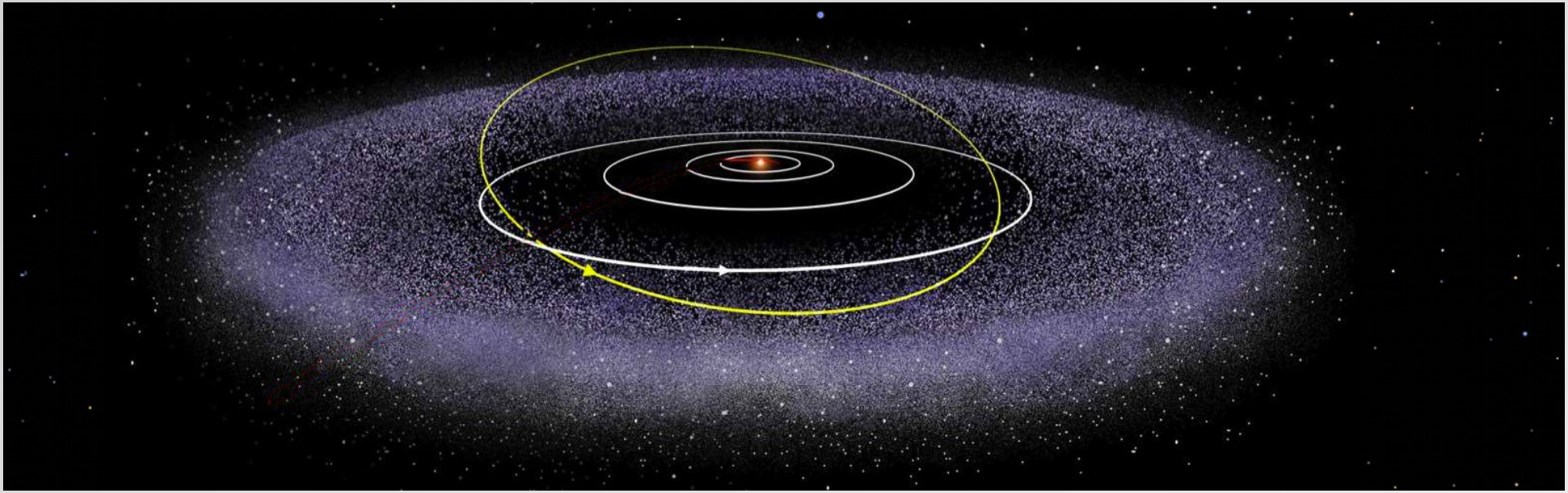

(NASA)

Patrick Cronin-Coltsmann
University of Warwick

The Kuiper Belt in Context

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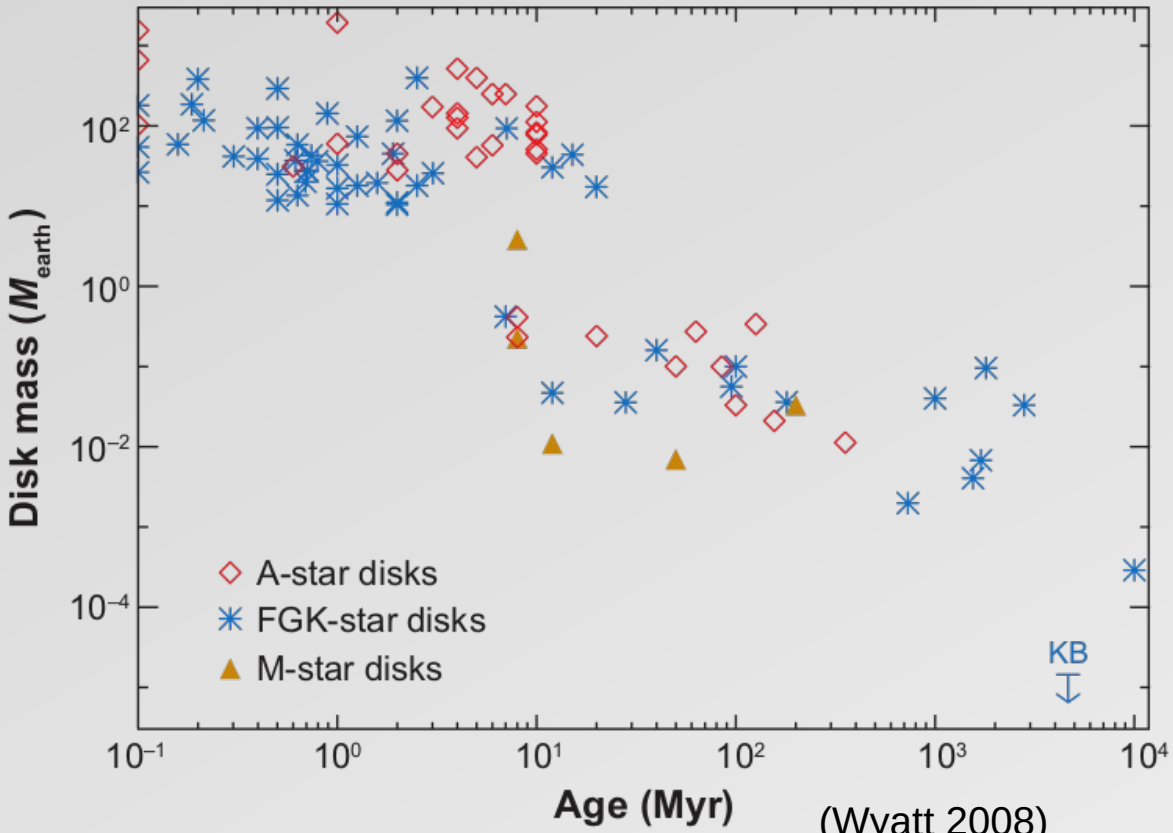
- Radius ~ 40 AU
- Temperature ~ 50 K
- Fractional Luminosity ~ 10^{-7}
- 4.5 Billion years old
- Would have started with much more mass
- Well below current detection limits



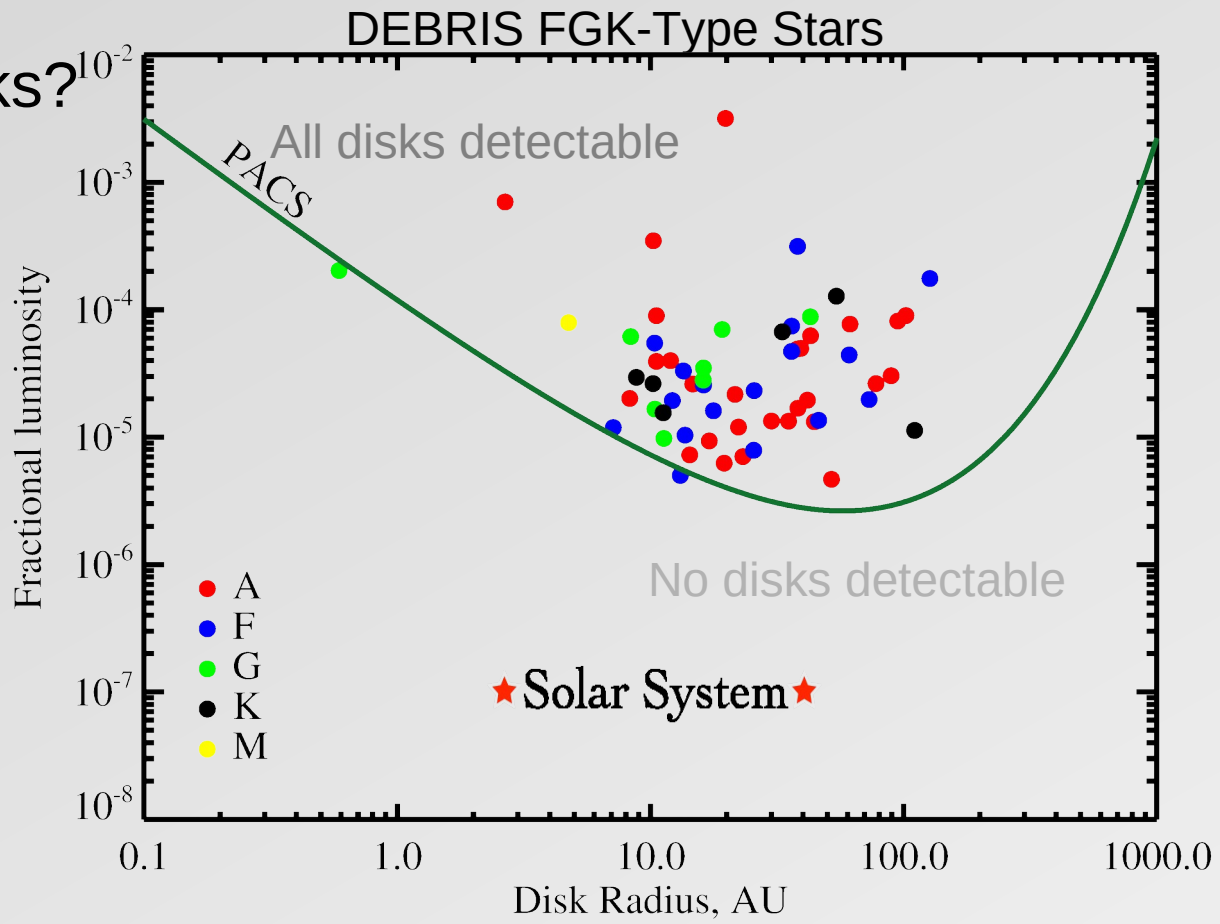
(Wyatt 2008)

The Kuiper Belt in Context

- Is its mass typical for a disk its age?
- Did planetary migration cause a catastrophic clearing event?
- How common are such disks?

True analogues remain undetectable and their incidence unknown.

They are beyond our *sensitivity limits.*



Fundamental Limitations

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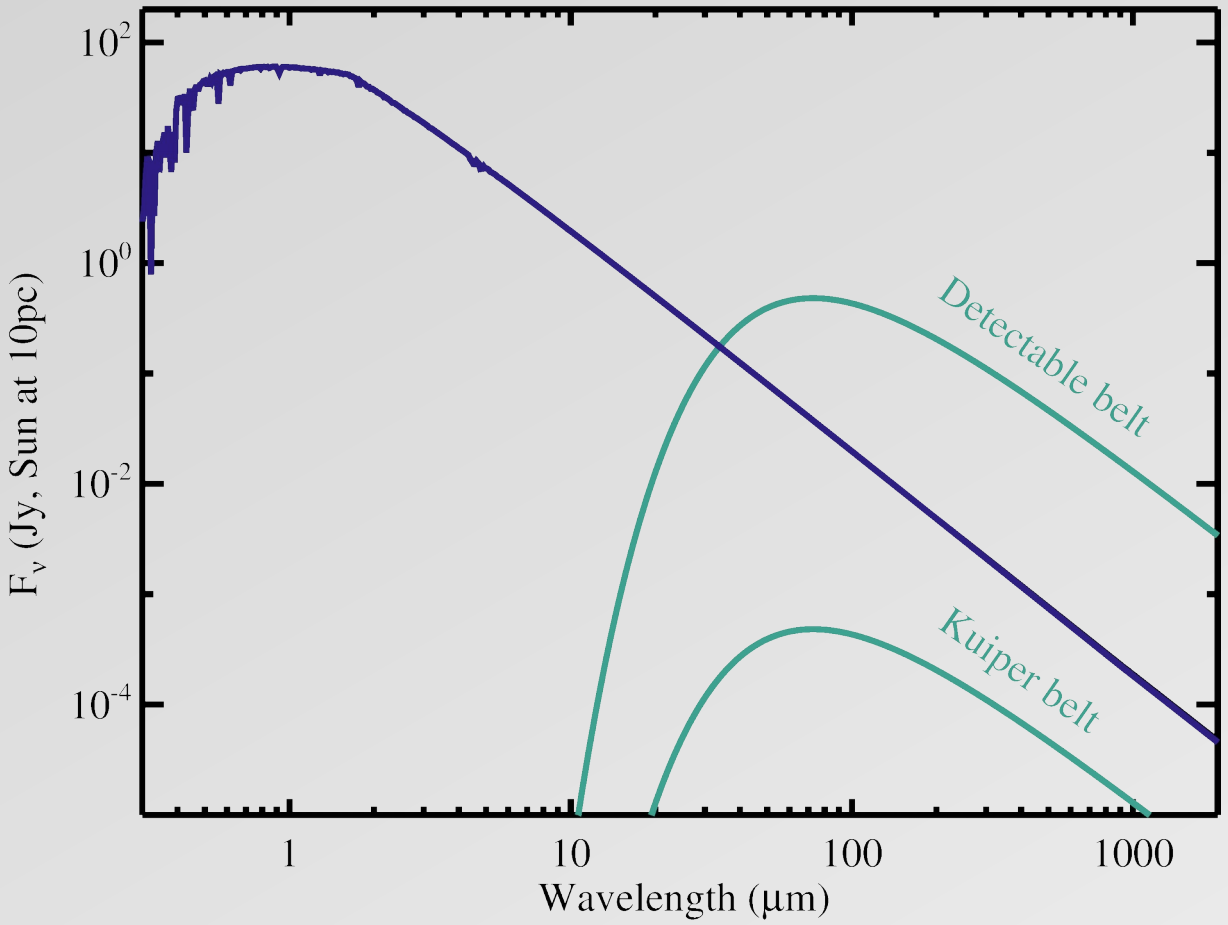
- Debris disks are detected by infrared excess
- Need to know what they are in excess *of*
- Would need both precise knowledge of stellar emission *and* instrumental variation and calibration



Fundamental Limitations

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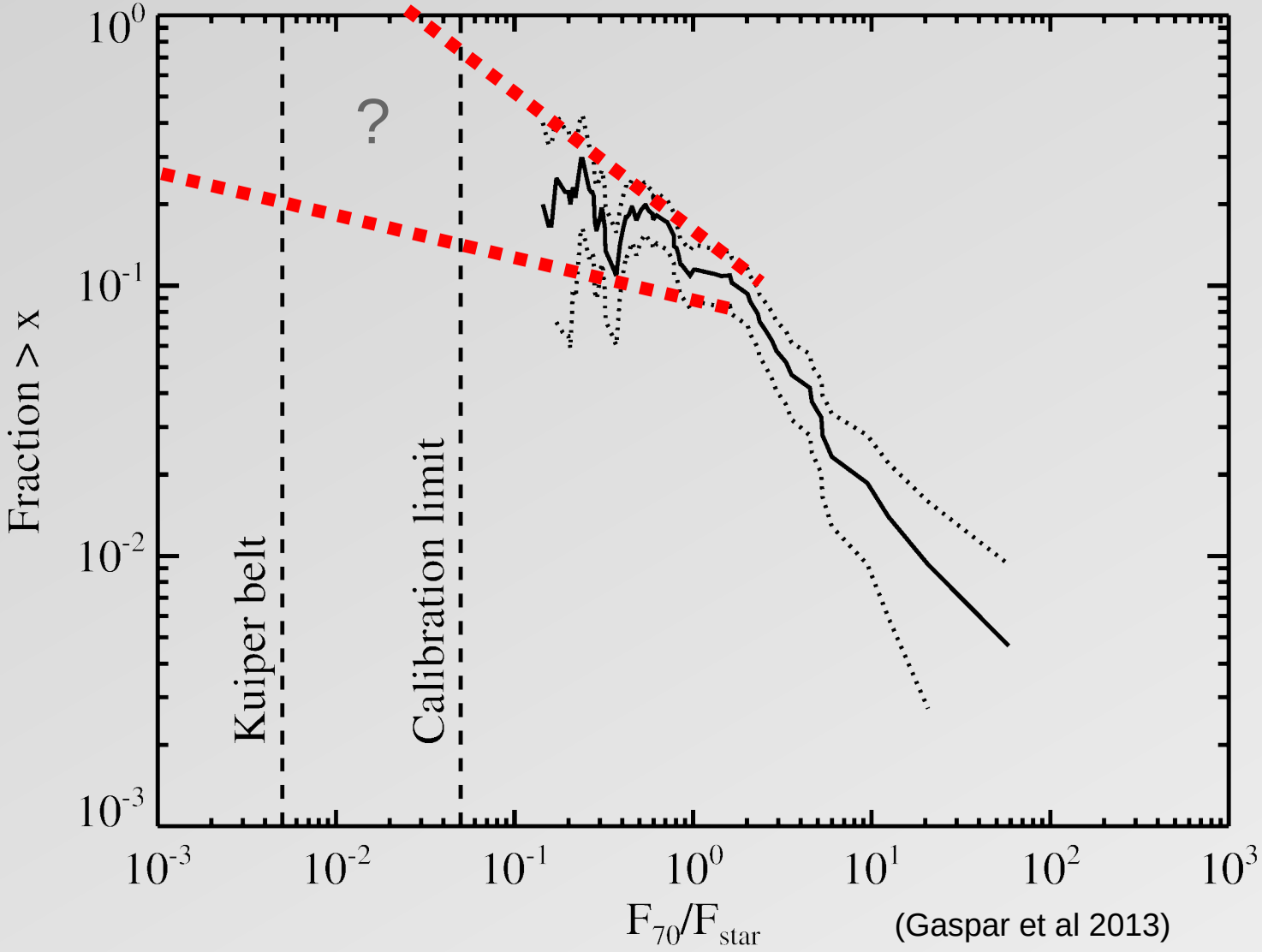
SPICA has the sensitivity to reach this *calibration limit.*

But true Kuiper belt analogues lie behind it.



(Gaspar et al 2013)

Fundamental Limitations

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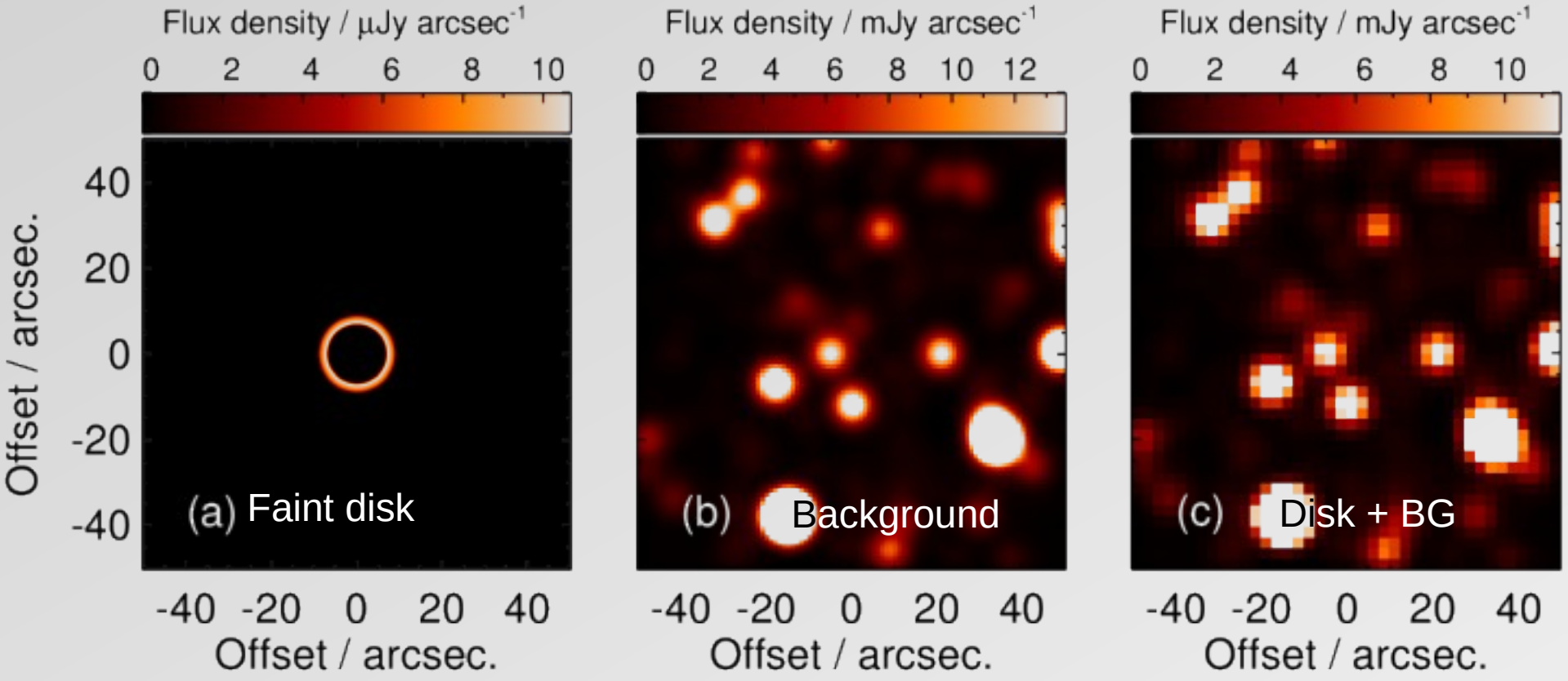
Resolving disks circumvents the calibration limit, but disks are as bright as the galaxies lying behind them.

Now restricted by this *confusion limit.*



Fundamental Limitations?

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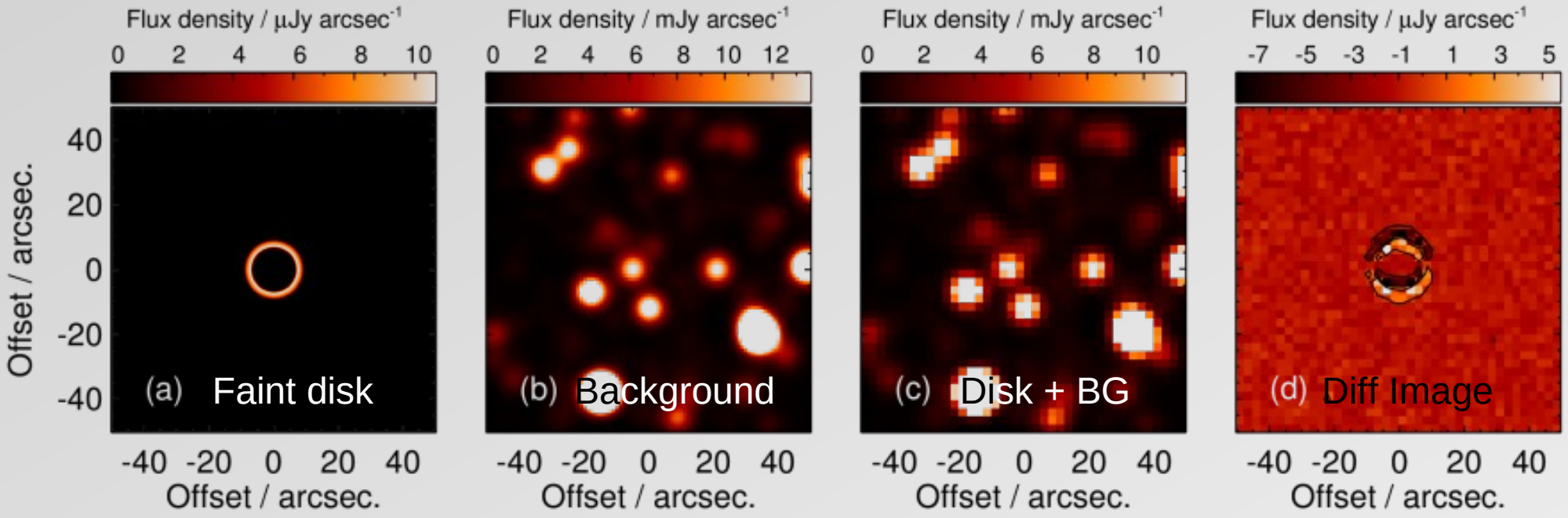
Choose high proper motion stars and difference image with snapshots from the beginning and end of the mission



A True Kuiper Belt Survey

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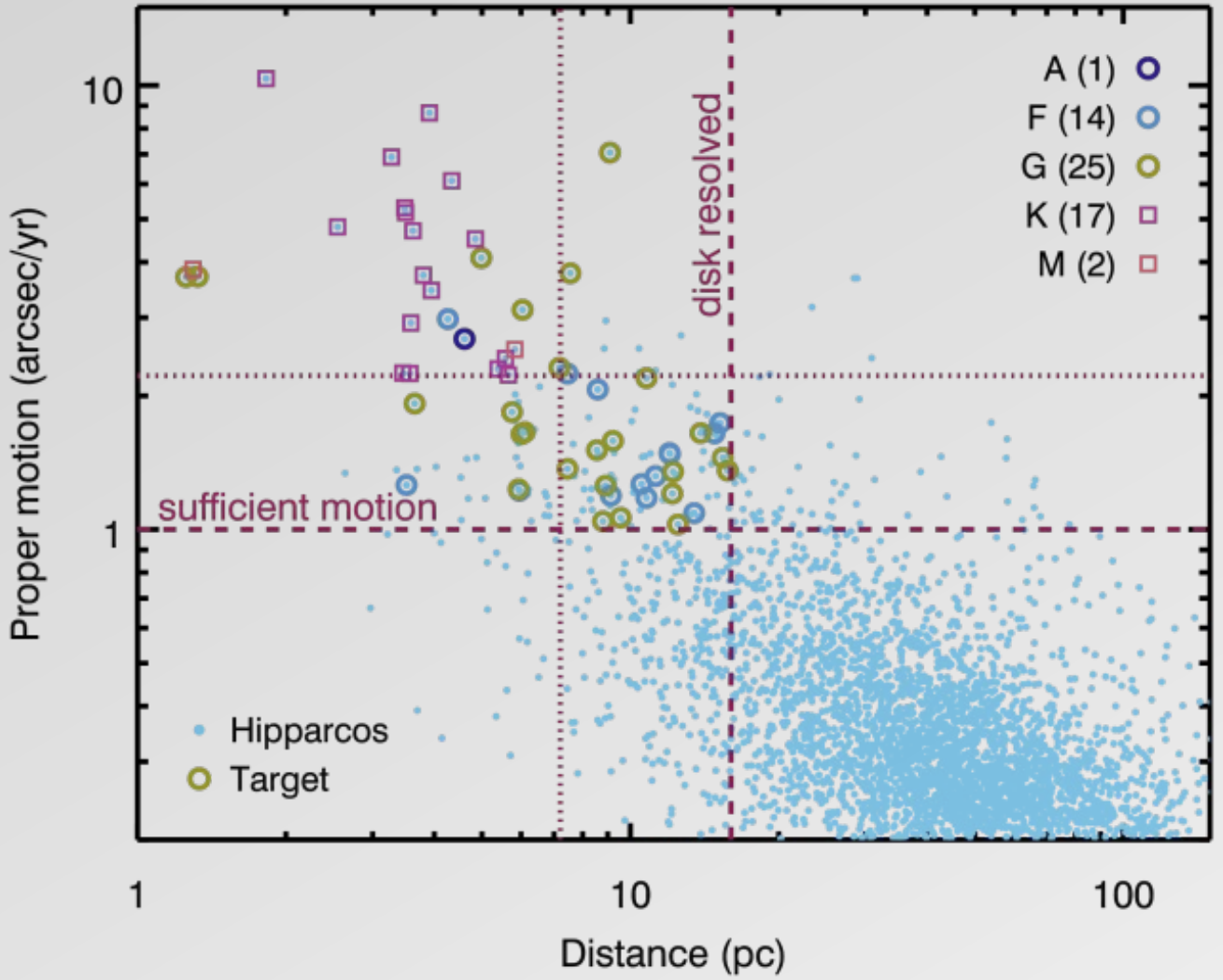
- Disks must be resolved
- Star must move at least half a beam FWHM
- Detections of both sunlike and low mass stars at 100 μm
- Full Kuiper belt distribution characterisation with spectral type would require a 50 μm imager
- Only SPICA would be capable of such a survey



A Debris Disk Luminosity Function

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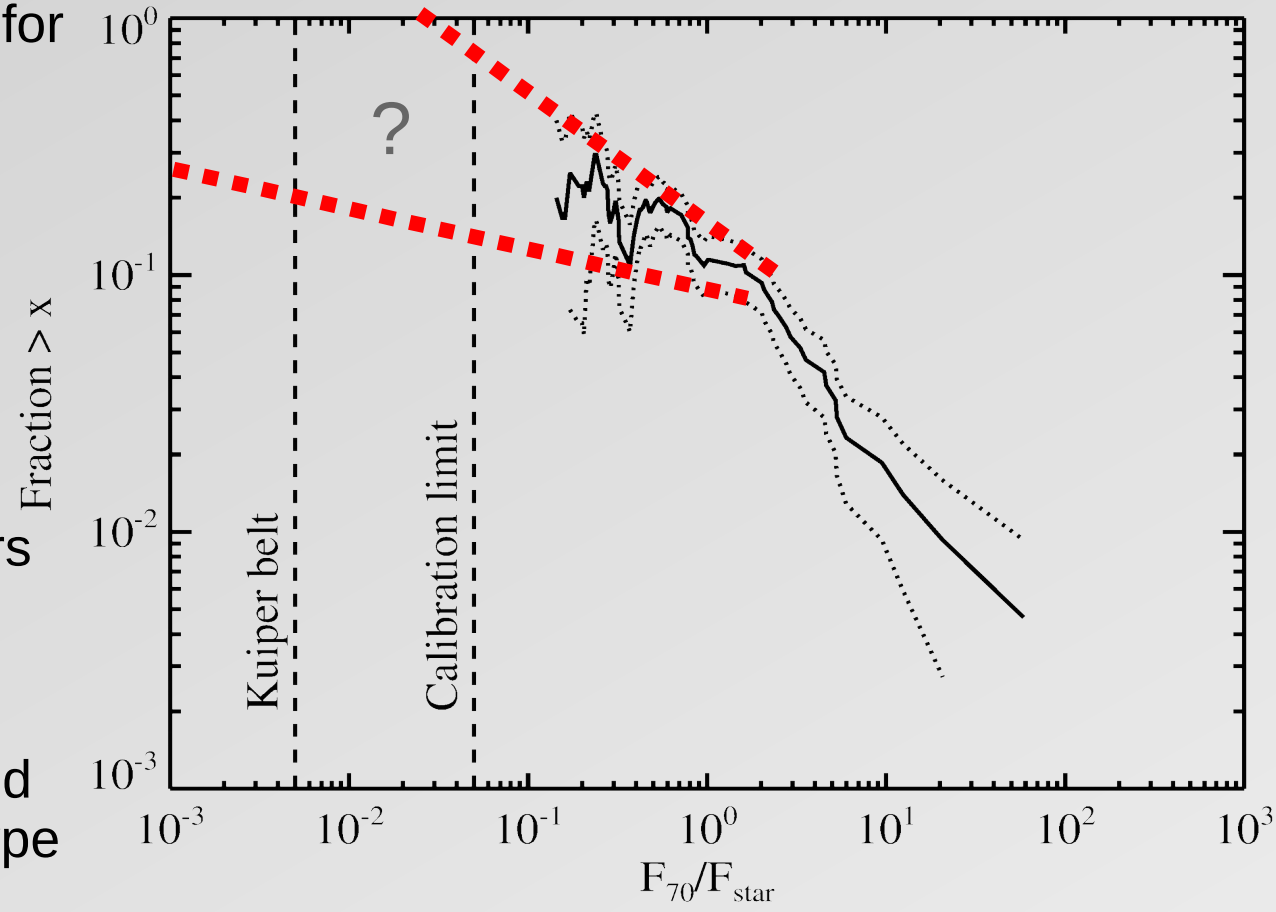
- SPICA's sensitivity also allow for a calibration limited large N survey
- Both new low mass disk parameter space and distant high mass disks
- Just a few minutes per star SAFARI could observe all stars where the calibration limit is reached
- As many stars as wanted could be observed, e.g. ~ 1000 G-type stars within 100 pc



Unprecedented statistical power could create a disk luminosity function and explore the relationship between disks and planets/metallicity/spectral type

Disks and Low Mass Stars

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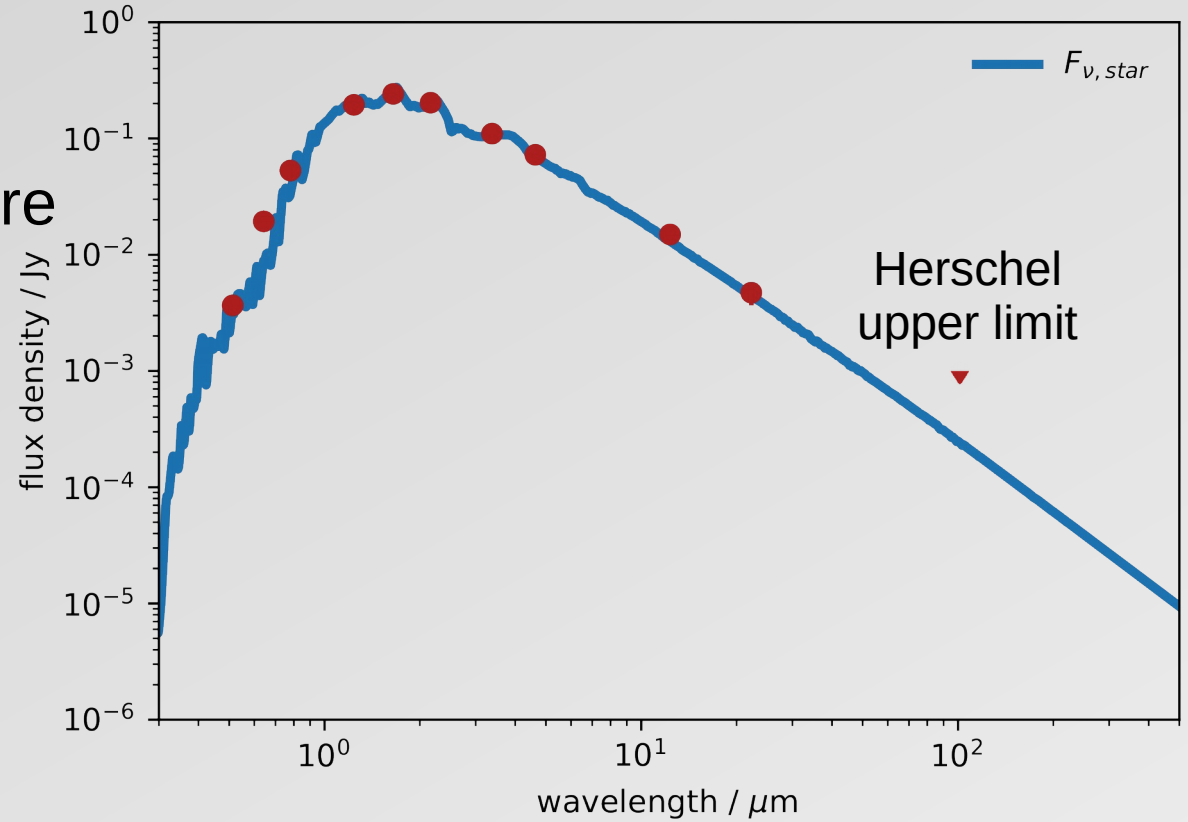
- Is planet formation super efficient around low mass stars?
- Historically difficult to measure disks due to low luminosity
- SPICA can measure real incidence rate to calibration limit and beyond
- Investigate whether current planet formation models are applicable to M dwarfs



Disks and Stellar Remnants

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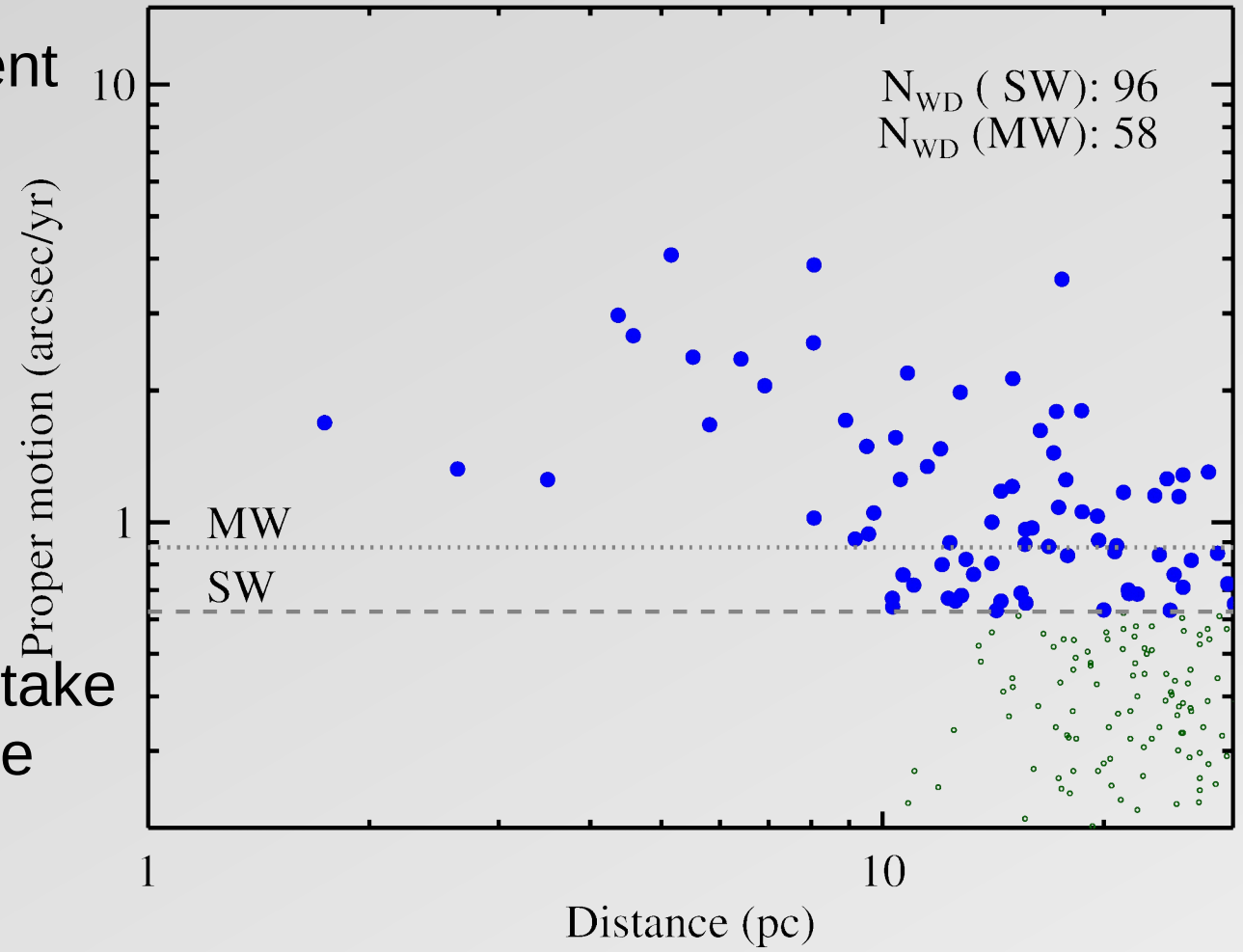
- Measured heavy element pollution in white dwarf atmospheres
- Believed to come from infalling circumstellar material
- SPICA could directly measure such disks or take proper motion difference images



Summary

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SPICA is uniquely capable of exploring new parameter spaces in debris disk science and performing ground breaking surveys

- Explore origins of pollution in stellar remnants
- Probe disks around low mass stars
- Investigate relationship between disks and planets
- Define a luminosity function for debris disks
- Measure true Kuiper belt analogue incidence rates