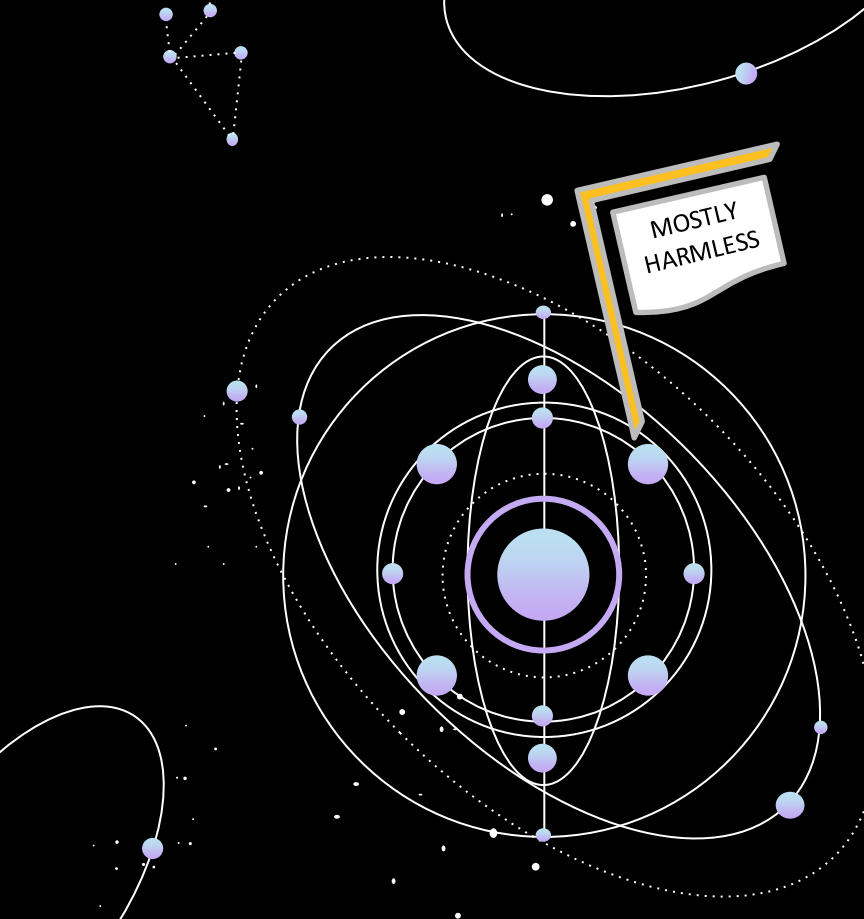
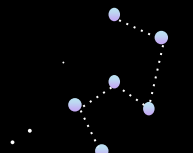




PLANET POPULATIONS: OR WHY WE NEED ROMAN

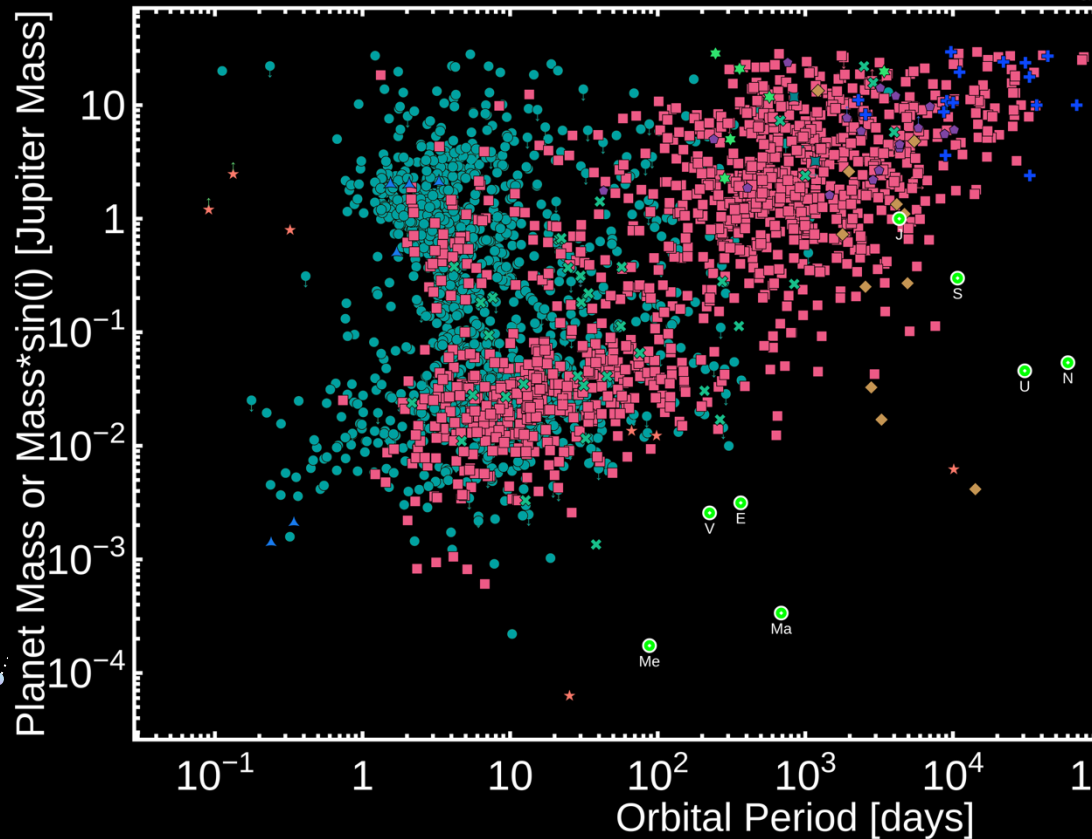
Jessie Christiansen – Caltech/IPAC
Sagan Summer Workshop – July 2026



PLANET POPULATIONS

Planet Mass or Mass $\sin(i)$ vs Orbital Period

exoplanetarchive.ipac.caltech.edu, 2026-07-09



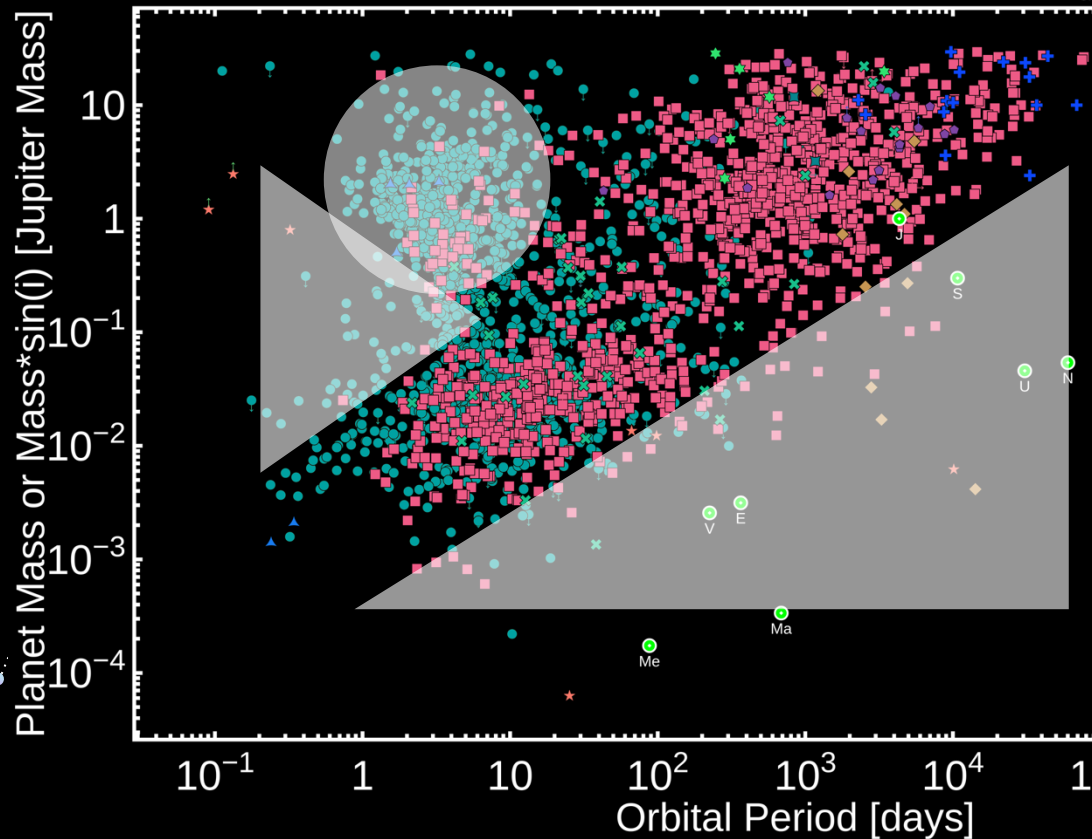
Look at the
distribution of known
planets

What features stand
out to you?
(e.g. clumps, gaps,
cliffs?)

PLANET POPULATIONS

Planet Mass or Mass* $\sin(i)$ vs Orbital Period

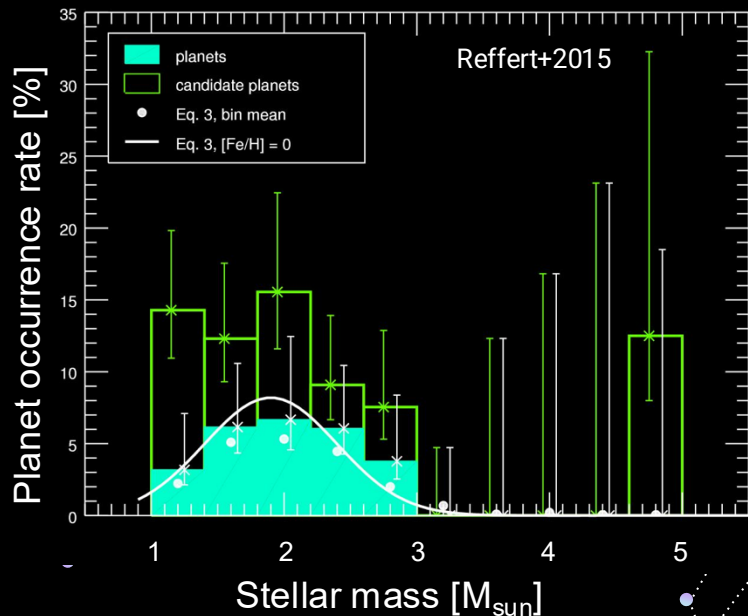
exoplanetarchive.ipac.caltech.edu, 2026-07-09



Understanding the underlying planet population tells us about the physics of planet formation, migration, and evolution

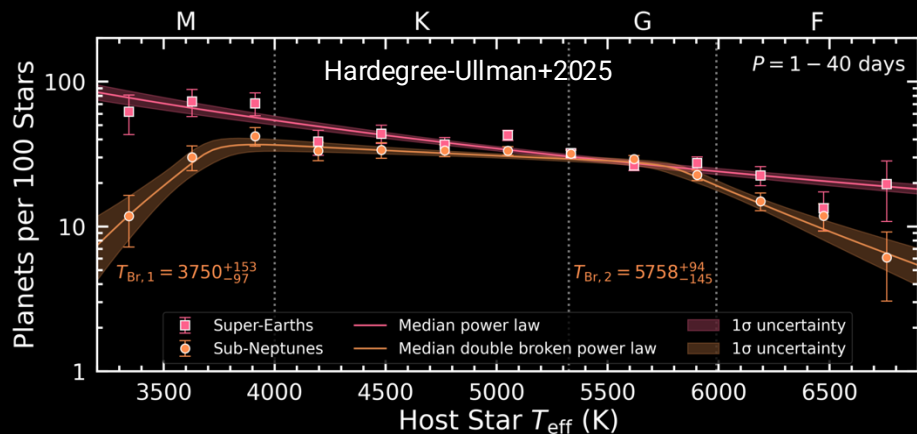
FACTORS WE OBSERVE THAT INFLUENCE OBSERVED PLANET POPULATIONS

Peak in giant planet occurrence $\sim 2M_{\text{sun}}$



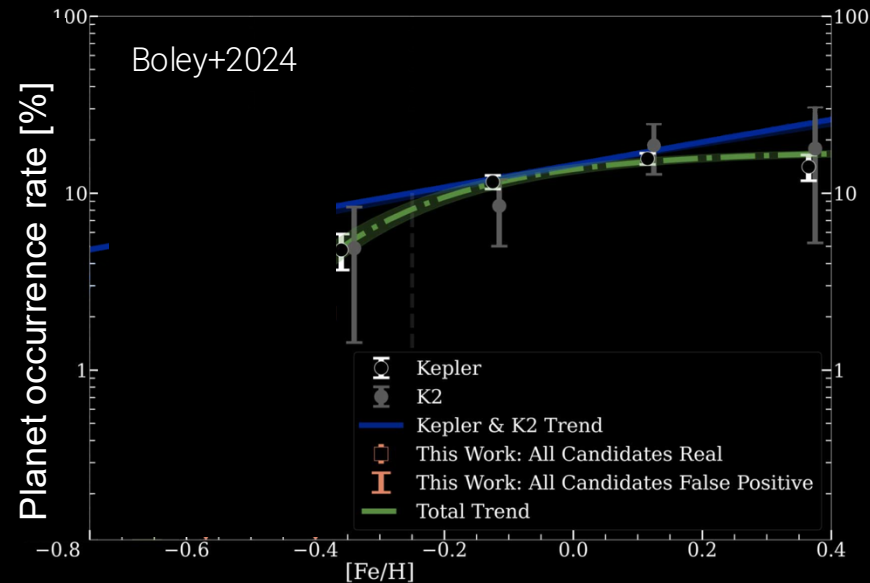
Stellar mass

Protoplanetary disk mass

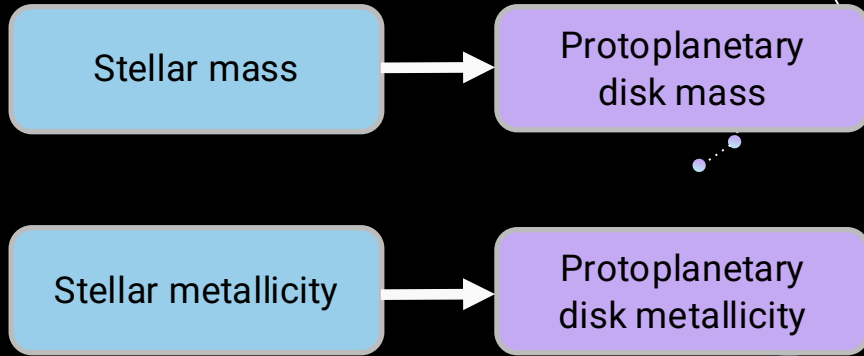


Peak in small planet occurrence at lower masses

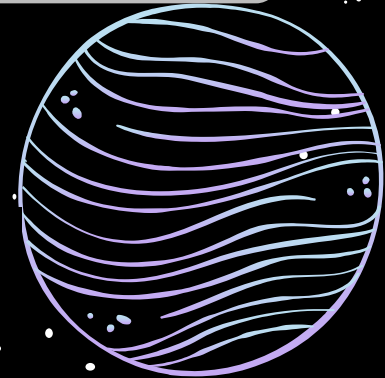
FACTORS WE OBSERVE THAT INFLUENCE OBSERVED PLANET POPULATIONS



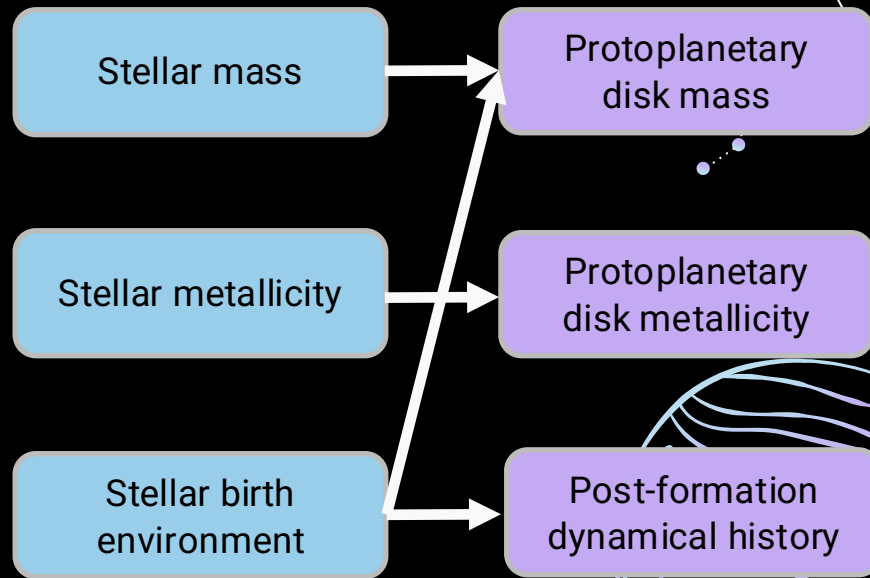
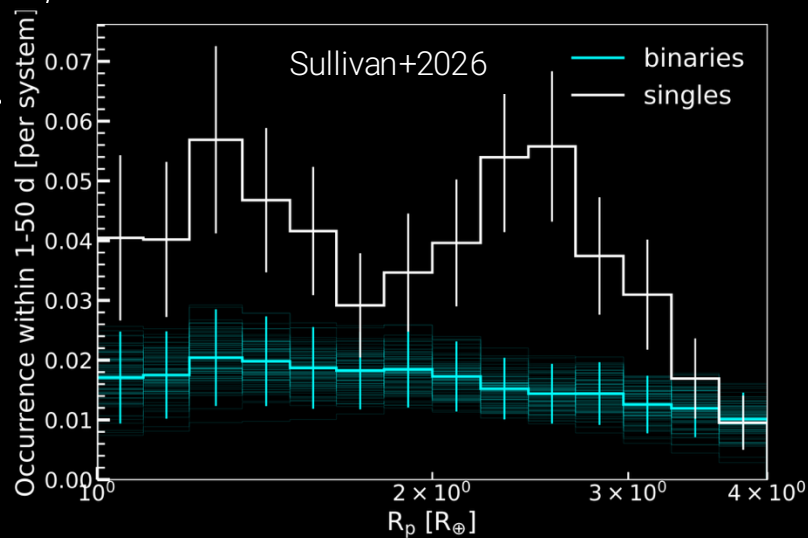
The most metal-poor stars
make very few planets



C.f. upcoming chemical
abundance results...

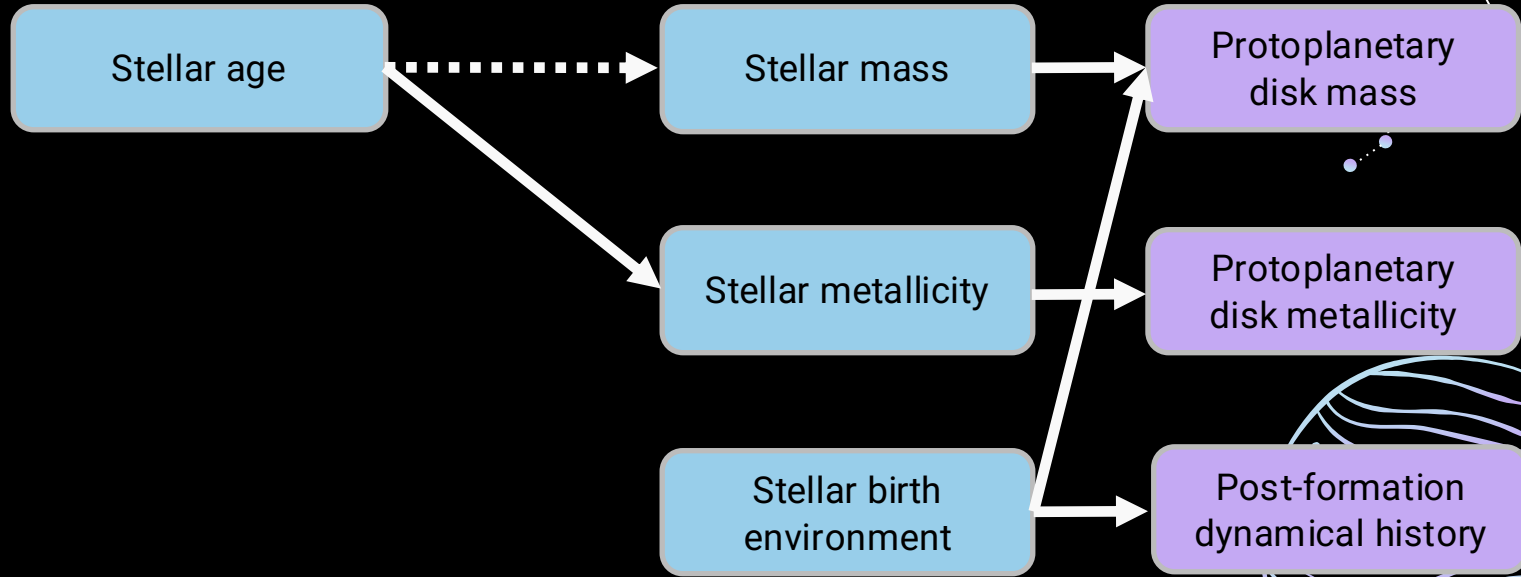


FACTORS WE OBSERVE THAT INFLUENCE OBSERVED PLANET POPULATIONS

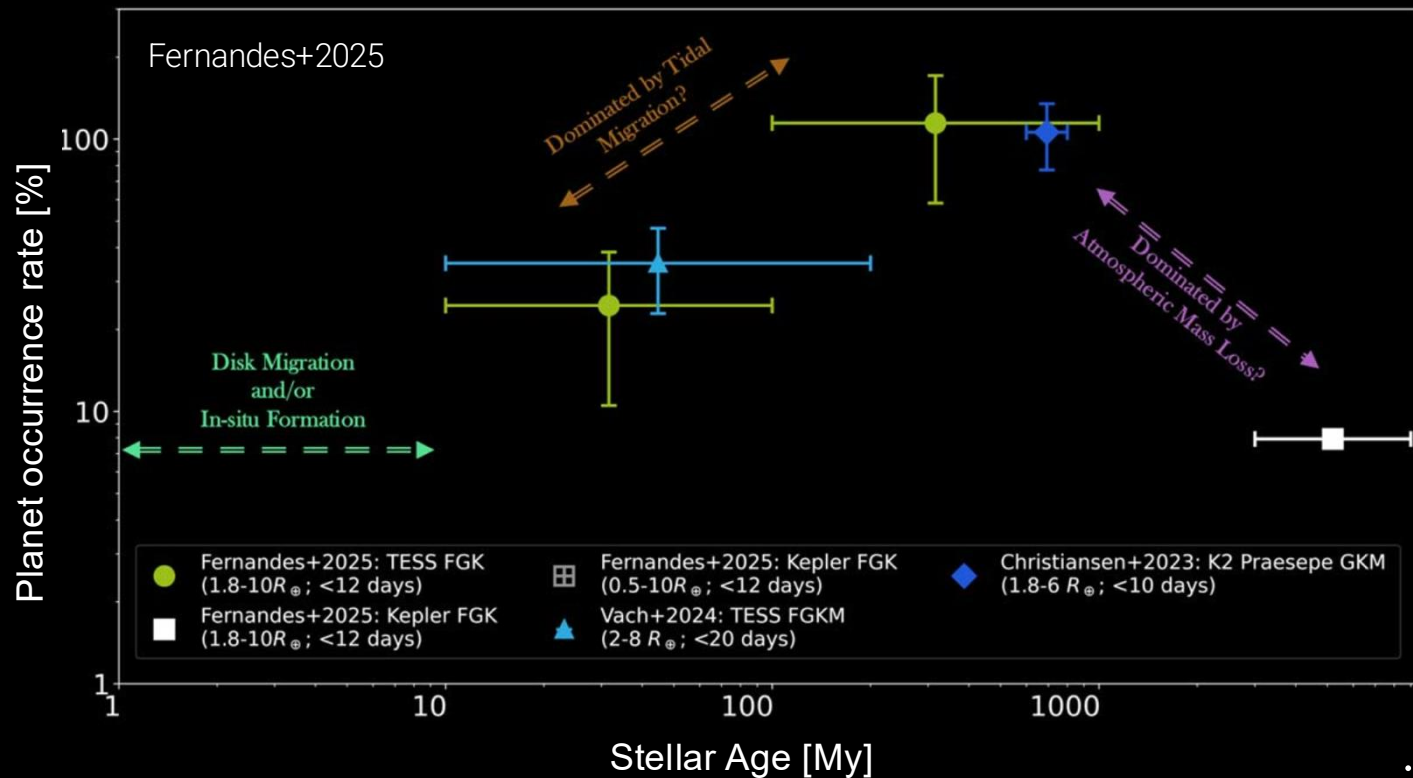


Come and ask me about SHERA!

FACTORS WE OBSERVE THAT INFLUENCE OBSERVED PLANET POPULATIONS



FACTORS WE OBSERVE THAT INFLUENCE OBSERVED PLANET POPULATIONS

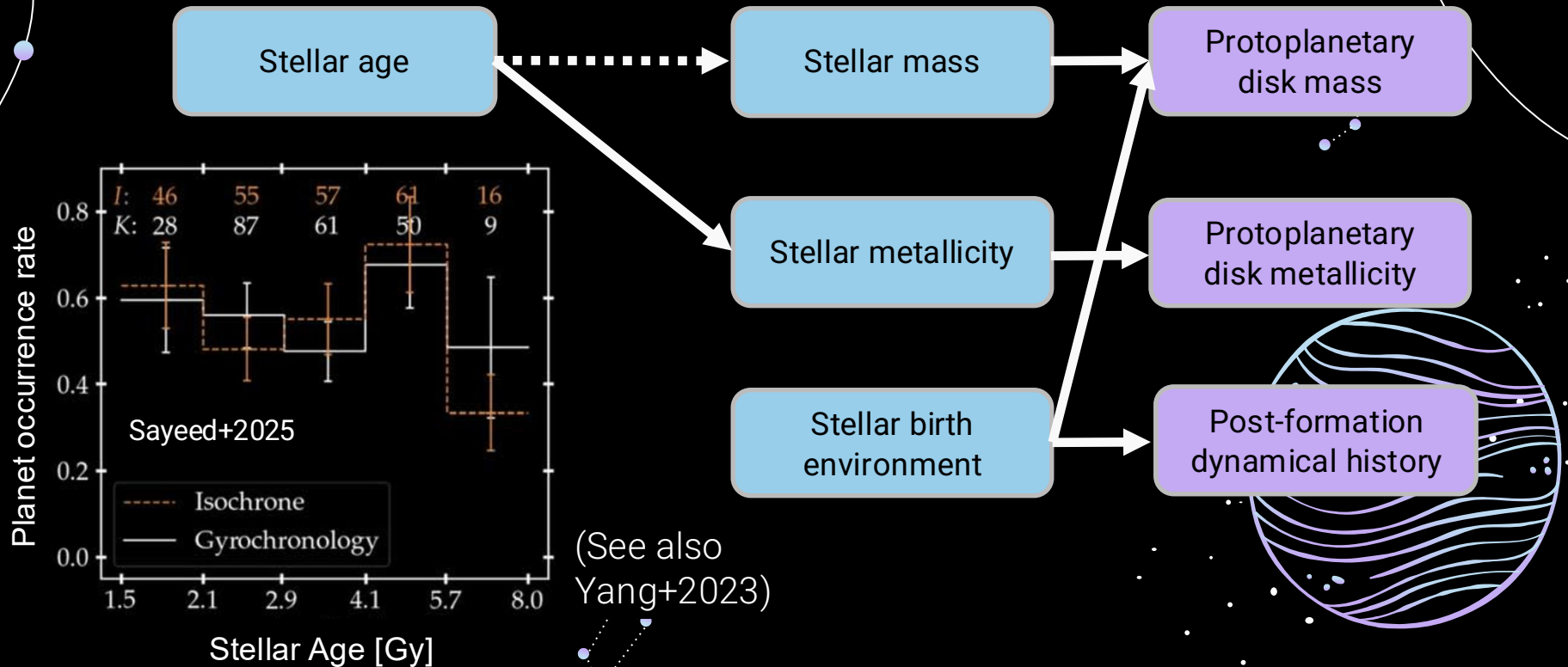


Protoplanetary
disk mass

Protoplanetary
disk metallicity

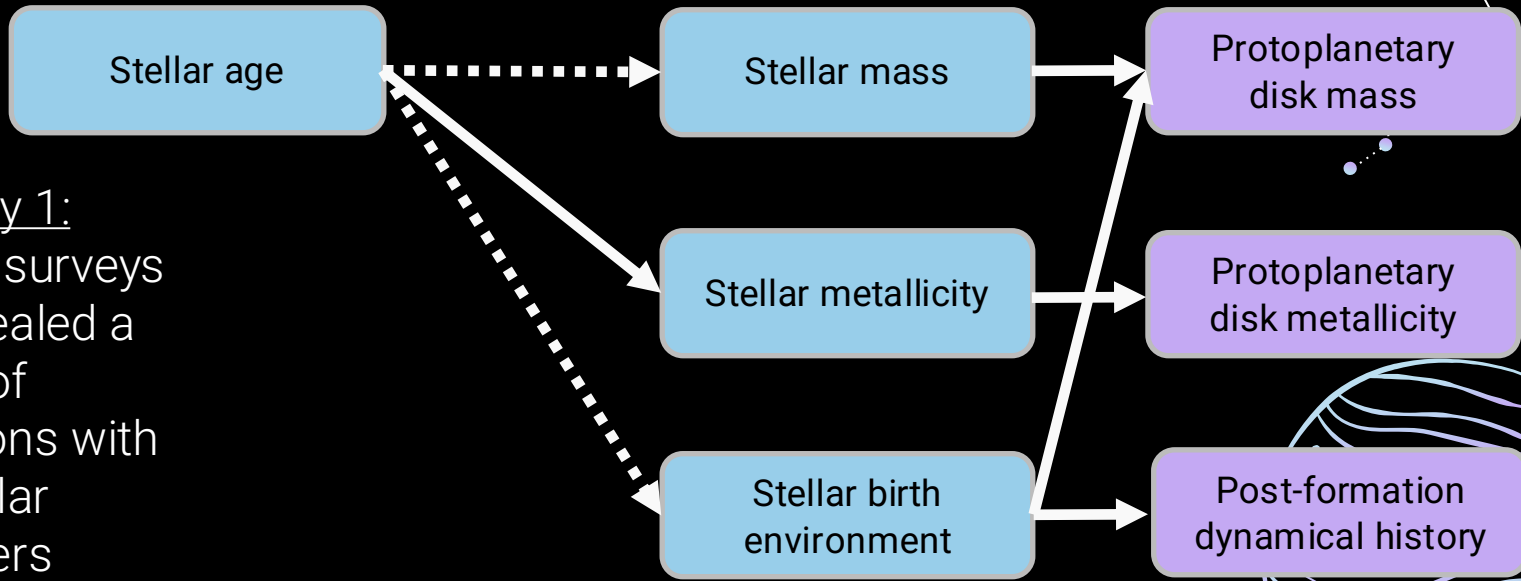
Post-formation
dynamical history

FACTORS WE OBSERVE THAT INFLUENCE OBSERVED PLANET POPULATIONS



FACTORS WE OBSERVE THAT INFLUENCE OBSERVED PLANET POPULATIONS

Takeaway 1:
Previous surveys
have revealed a
number of
correlations with
local stellar
parameters



✓ Takeaway 2:
Stellar properties
that influence
planet populations
also vary with
galactic location
in interdependent
ways



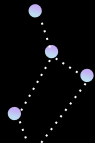
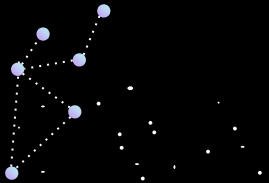
IT'S TIME TO THINK BIGGER...



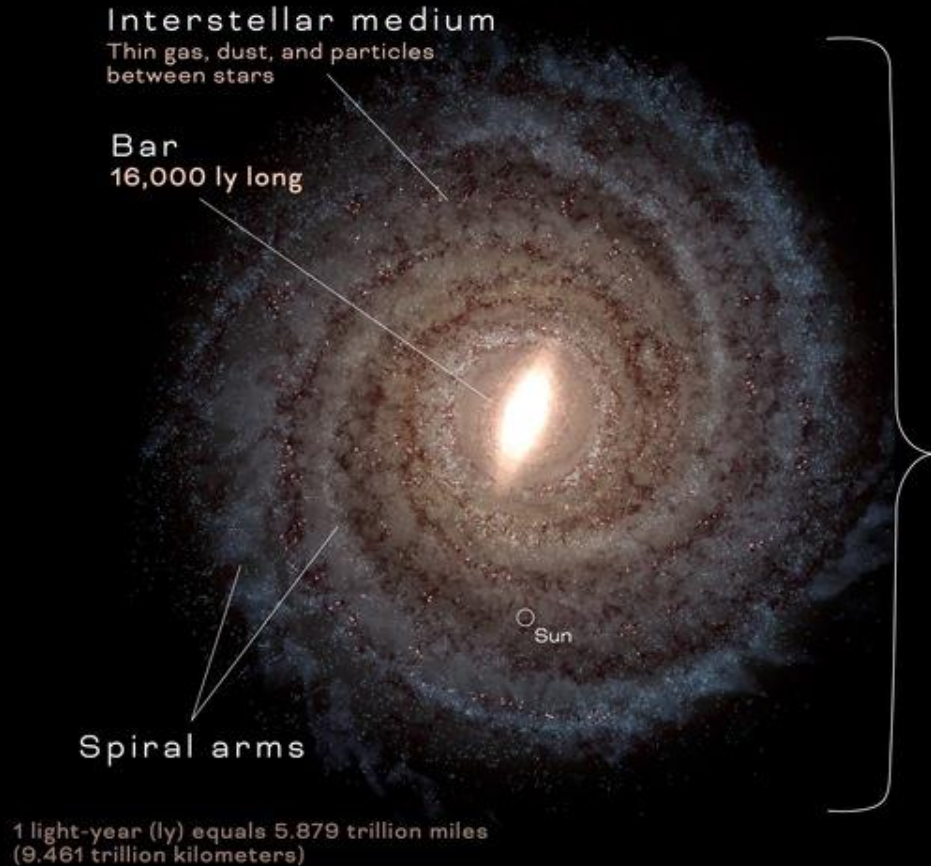
... KNOW THY
STAR,
KNOW THY PLANET

IT'S TIME TO THINK BIGGER...

... KNOW THY
~~STAR~~,
KNOW THY PLANET

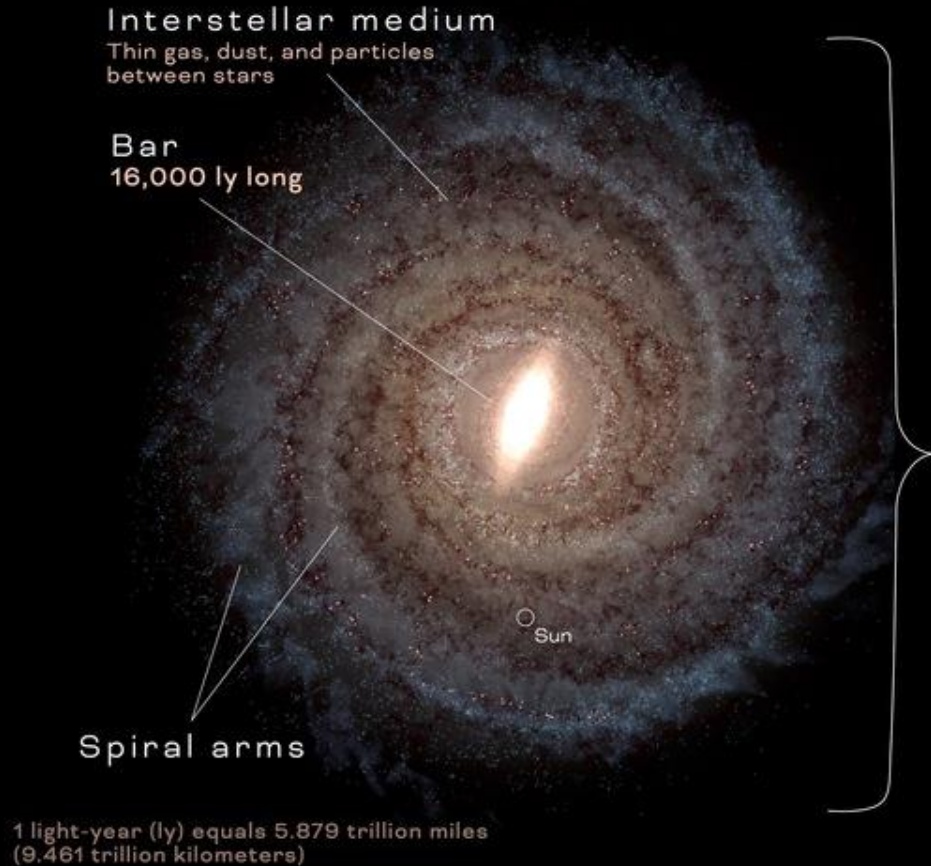


IT'S TIME TO THINK BIGGER...



... KNOW THY
GALAXY,
KNOW THY PLANET

IT'S TIME TO THINK BIGGER...



... KNOW THY
GALAXY,
KNOW THY PLANET

HOW DOES GALACTIC LOCATION FURTHER INFLUENCE PLANET POPULATIONS?



Think about what you know about galaxies

(It's okay if it's not much!)

What are some galactic processes that could influence planet formation and evolution?

HOW DOES GALACTIC LOCATION FURTHER INFLUENCE PLANET POPULATIONS?

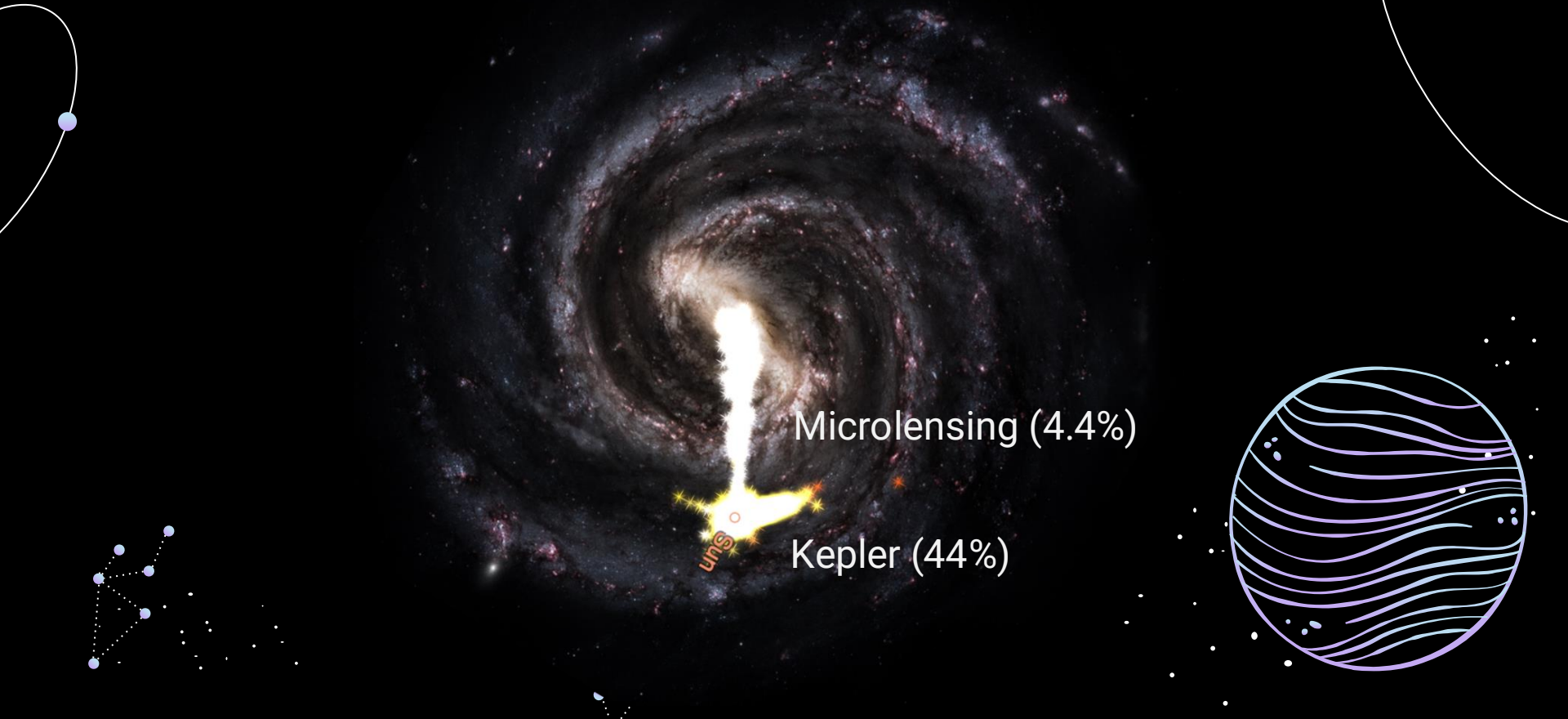


Galactocentric velocities
Galactic birth radii
Dynamical history
Insolation history
Star formation history
Cosmic ray distribution
Your guess here!

(N.B. these are all similarly interdependent!)

Can we isolate the impact of galactic processes?

WHERE HAVE WE LOOKED SO FAR?

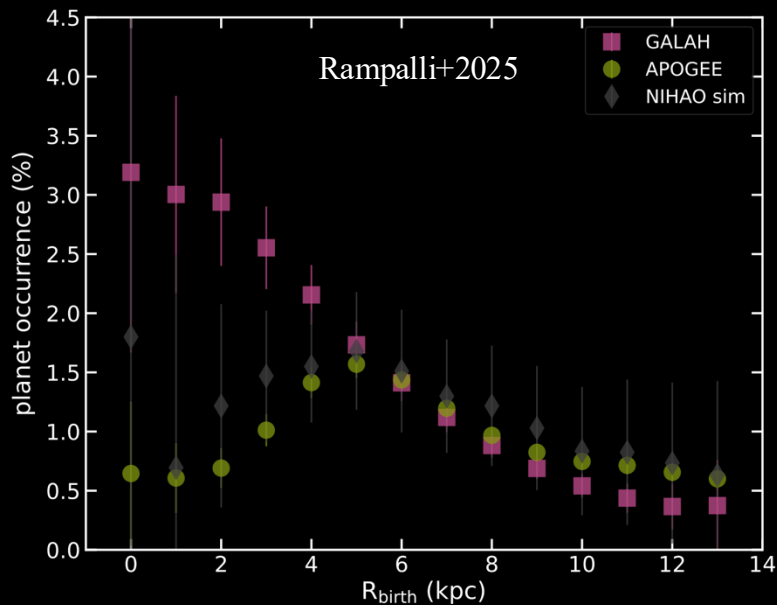


Microensing (4.4%)

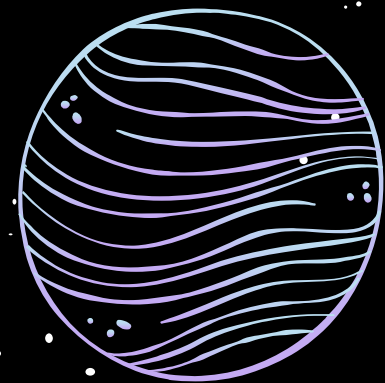
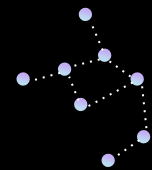
Kepler (44%)

Sun

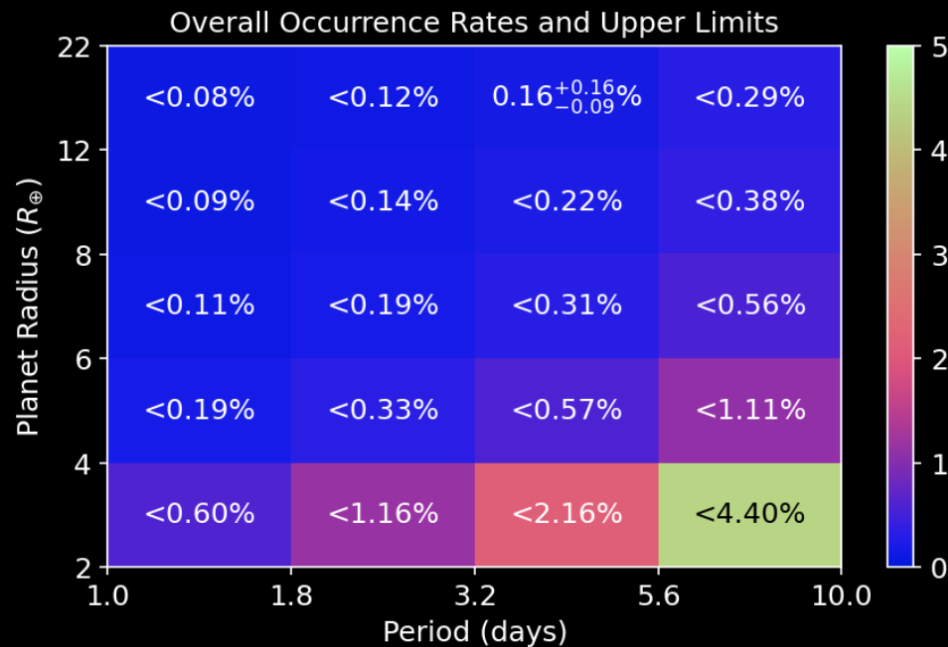
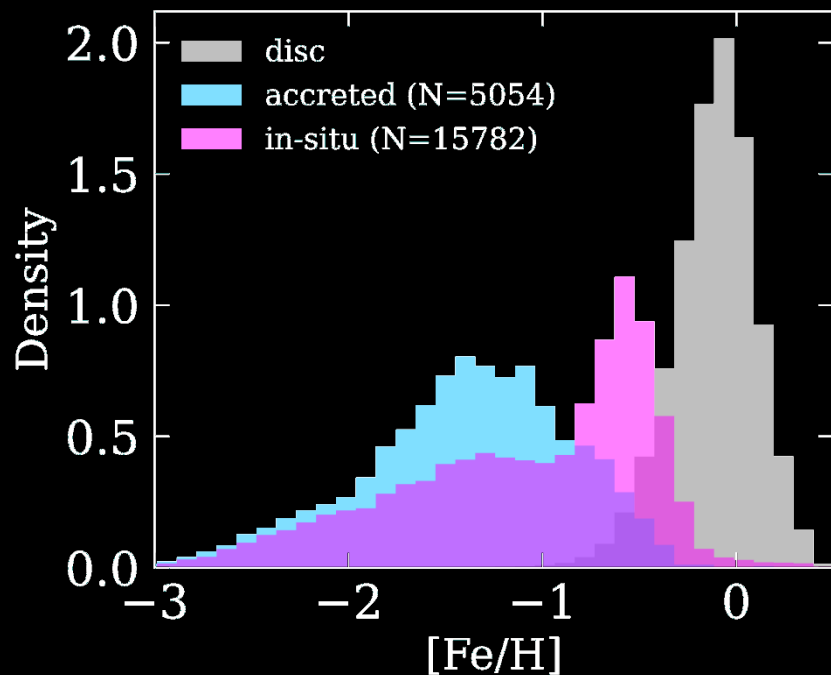
WHAT TRENDS DO WE SEE WITH GALACTIC PROPERTIES?



Prediction of hot-Jupiter occurrence rates with galactocentric radius, based on metallicity trend → hot Jupiters should be orbiting kinematically cool, metal-rich stars

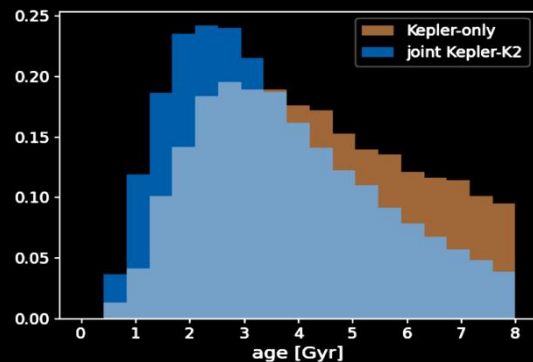
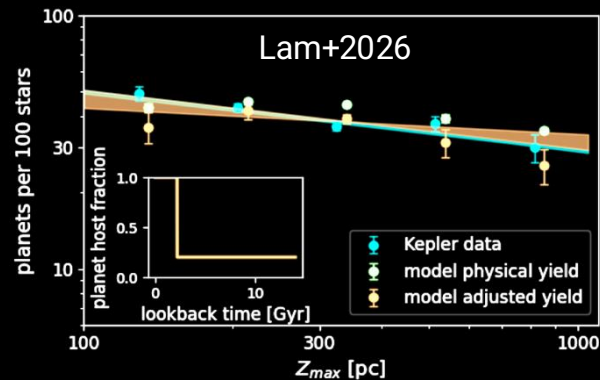
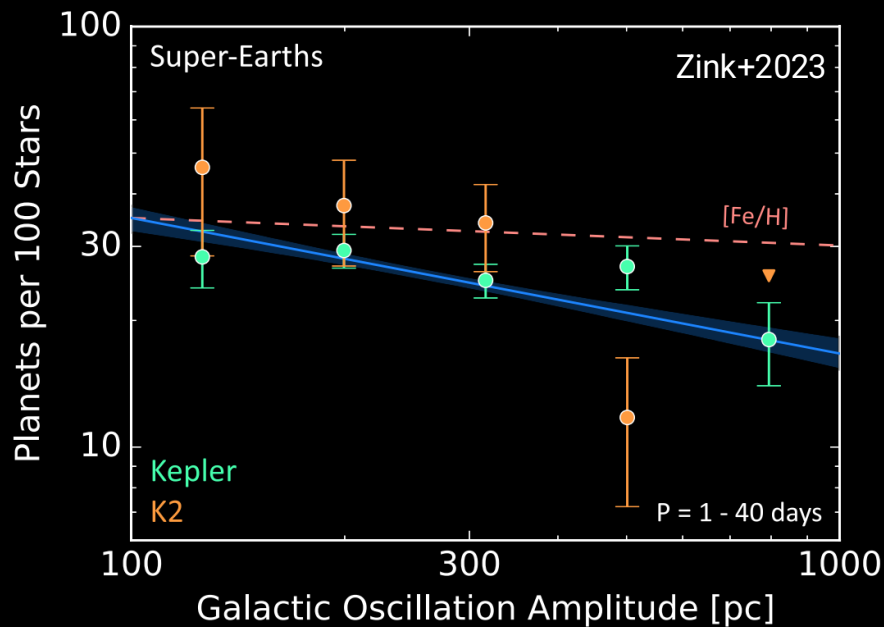


WHAT TRENDS DO WE SEE WITH GALACTIC PROPERTIES?



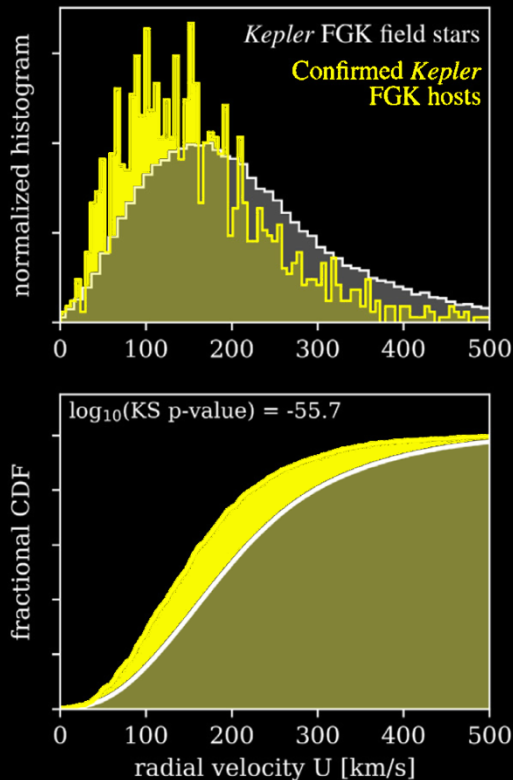
Bashi+2026, c.f. earlier results from Boley+2021

WHAT TRENDS DO WE SEE WITH GALACTIC PROPERTIES?

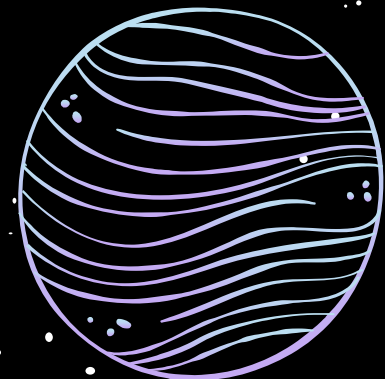
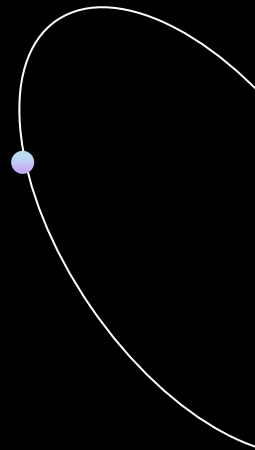
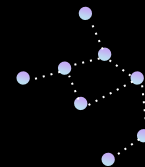
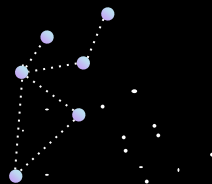
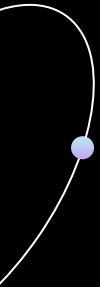


WHAT TRENDS DO WE SEE WITH GALACTIC PROPERTIES?

McTier &
Kipping
2019



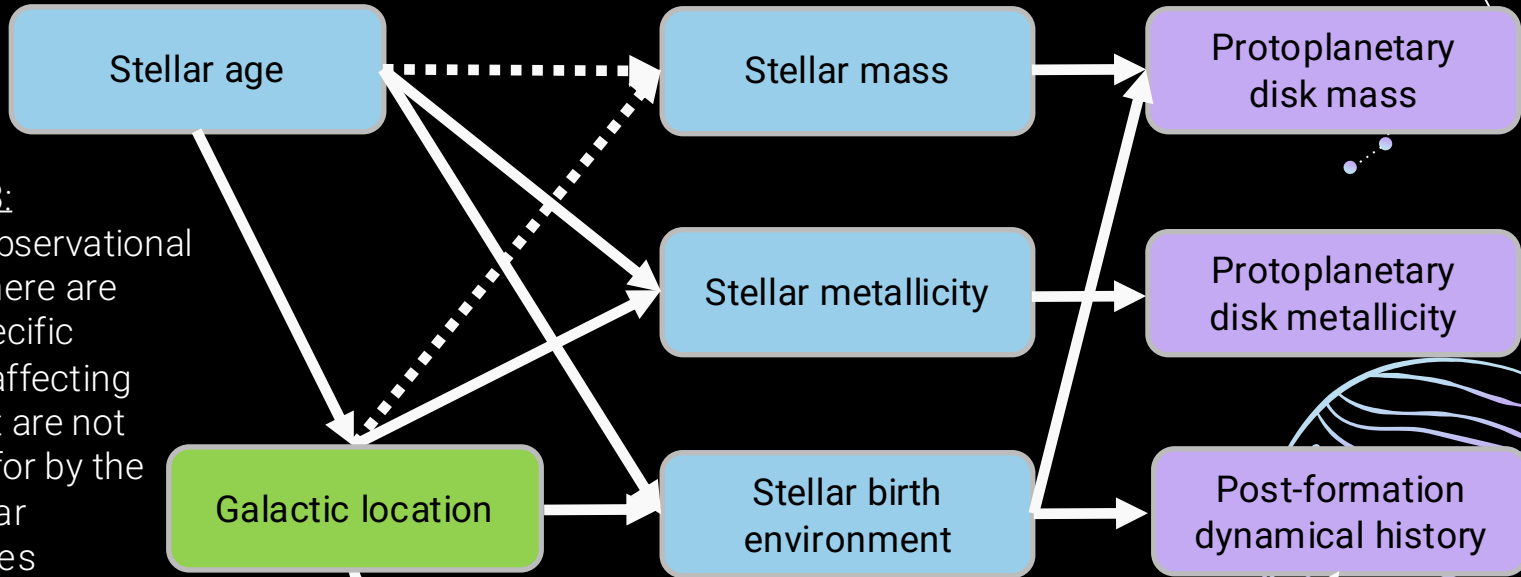
Kepler hosts have slower galactocentric velocities than non-hosts – selection function? But Yang+2023 think it's real...
... but is it yet another age effect?



HOW DOES THIS HELP US WITH THE GALACTIC CENSUS OF PLANETS??

Takeaway 3:

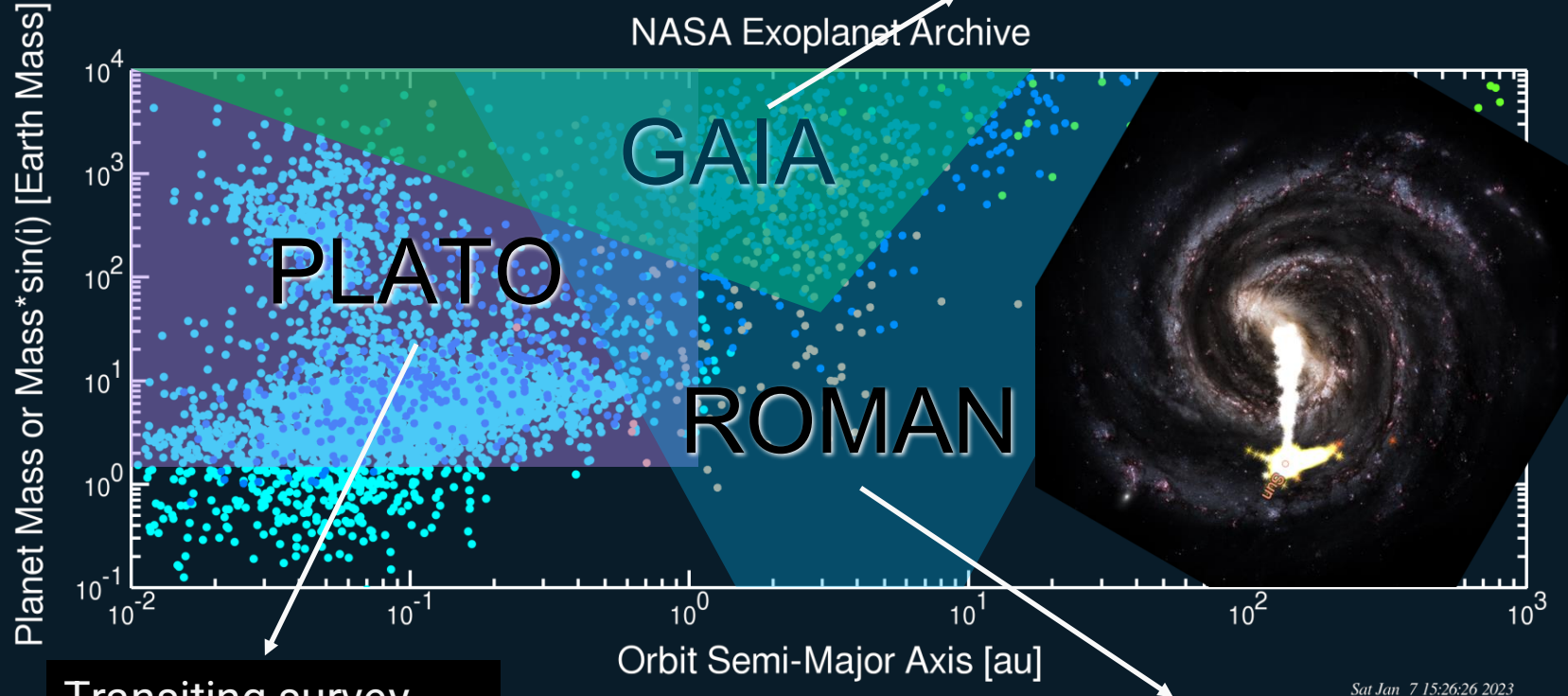
There are observational hints that there are galactic-specific processes affecting planets that are not accounted for by the known stellar dependencies



SO WHAT'S NEXT?

Astrometric survey
Stellar velocities

NASA Exoplanet Archive



Transiting survey
Stellar ages

Microlensing and transiting surveys
New Galactic parameter space

SUMMARY

1. Previous surveys have revealed a number of correlations with **local** stellar parameters
2. Stellar properties that influence planet populations **also** vary with galactic location in interdependent ways
3. There are hints that there are galactic-specific processes affecting planets that are **not** accounted for by the known stellar dependencies
- 4. We are about to be able to test these processes!***

