How asteroseismology can help to precisely constrain properties of planet-host stars

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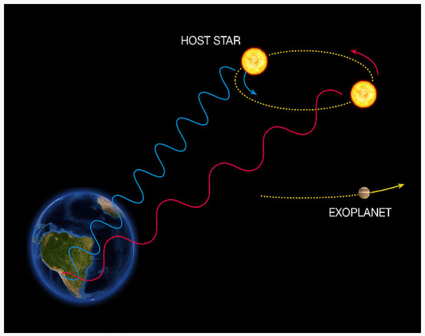
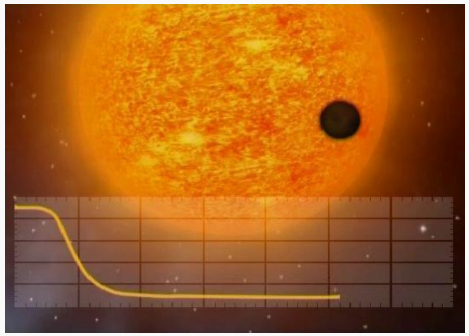
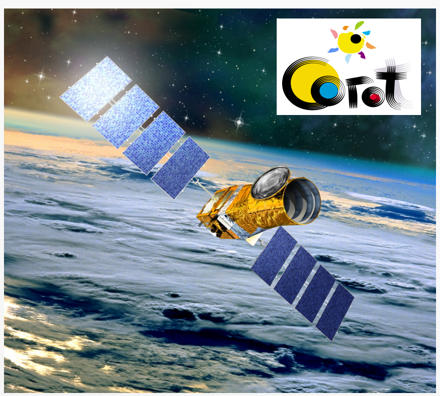


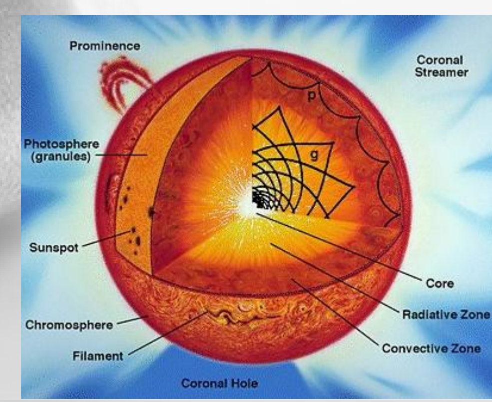


More than 500 known exoplanets (about 100 transiting)

The probem: need of <u>accurate</u> M_* and R_* to characterize planetary M_p and R_p



Seismology of Sun-like stars can better constrain the properties of the host-star



Relative error on	M (spectro)	R (spectro)	M (seismo)	R (seismo)
HAT-P-7 [1,2]	44 %	9 %	2 %	1 %
HD 46375 [3,4]	15 %	4 %	5 %	3 %
μ Arae [3,5]	8 %	1 %	2 %	4 %
HD 17156 [6,7]	8 %	10 %	2 %	<1 %

Global oscillation modes in the evolving disk of B emission stars

Finny Oktariani , Hokkaido University

B emission (Be) stars : Show Balmer lines in emission.

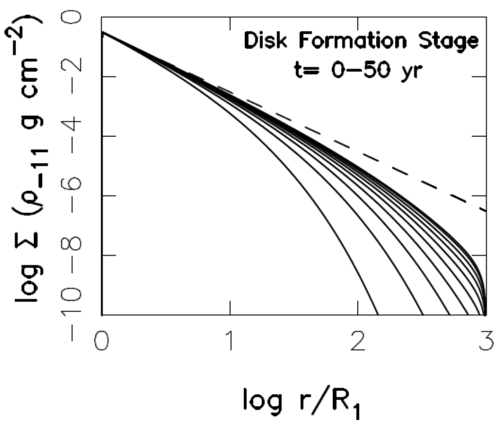
Emission lines → cool circumstellar disk

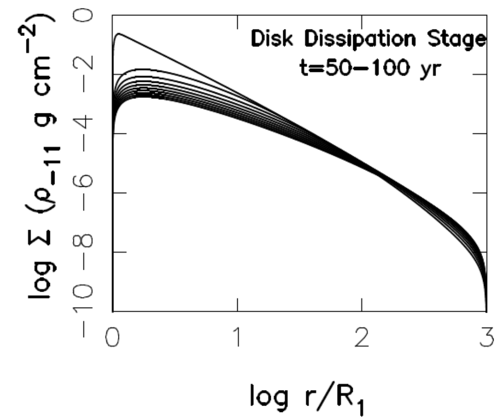
V/R variations: line profile variability caused by global disk oscillation (m=1) mode with period about several years.

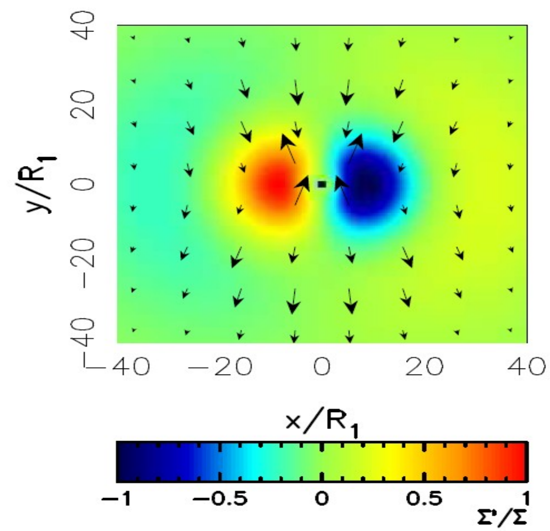
More remarkable variability in disk formation stage than in disk dissipation stage.

See poster for more details

Evolving disk :







Probing the atmosphere of the 'hot jupiter' TrES-1b with HST

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The structure and chemical composition of the atmosphere of transiting exoplanets can be studied using transmission spectroscopy. The radius of a transiting planet varies with wavelength due to the chemistry of its different atmospheric layers. This work reviews the HST transit observations (5000 – 10000 Å) of the hot gas giant exoplanet TrES-1b. The atmosphere of this planet is analysed, comparing the observed transmission spectrum to synthetic model spectra.

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On Using the Color-Magnitude Diagram Morphology of M67 to Test Solar Abundances

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Aim of this work

The chemical composition of the Sun had been assumed to be known very accurately, e.g. see Grevesse et al. 1998 (**GS98**). However, a recent determination by Asplund et. al 2005 (**AGS05**) revised the **solar abundances** (SA), in particular CNO-elements, downward by more than 30%. The open cluster M67 has solar metallicity and an age of about 4 Gyr. The morphology of the **color-magnitude diagram (CMD) of M67** around the turnoff (TO) shows a clear **hook-like feature**, a direct sign that stars close to the TO have a **convective core** (CC). VandenBerg et al. 2007 (VG07) investigated the possibility of using the morphology of the M67 TO to put **constraints on the solar metallicity**. Here, we extend their work, filling the gaps in their analysis. To this aim, we compute isochrones appropriate for M67 using new (low metallicity) and old (high metallicity) SA and study whether the **characteristic TO of M67 can be reproduced or not**. We also study the importance of other constitutive physics on determining the presence of such a hook, particularly **element diffusion**, **overshooting** and **nuclear reaction rates**. The presented findings are already published in Magic et al. 2010.

Recovering VG07

In the first place, we were able to confirm the findings of VG07. Therefore, we computed isochrones with our stellar evolution code (**GARSTEC**, see Weiss et al. 2008 for a detailed description) for both SA and applied the same color-transformation and photometrical parameters for M67, which are shown in Fig. 1. The new SA (AGS05) lacks clearly the hook-like TO morphology, while the old composition (GS98) reproduces it well. This comes due to the fact that the development of a CC on the main-sequence, as a result of the dominance of the CNO-cycle over the pp-chain, is less likely by virtue of the lower metallicity.

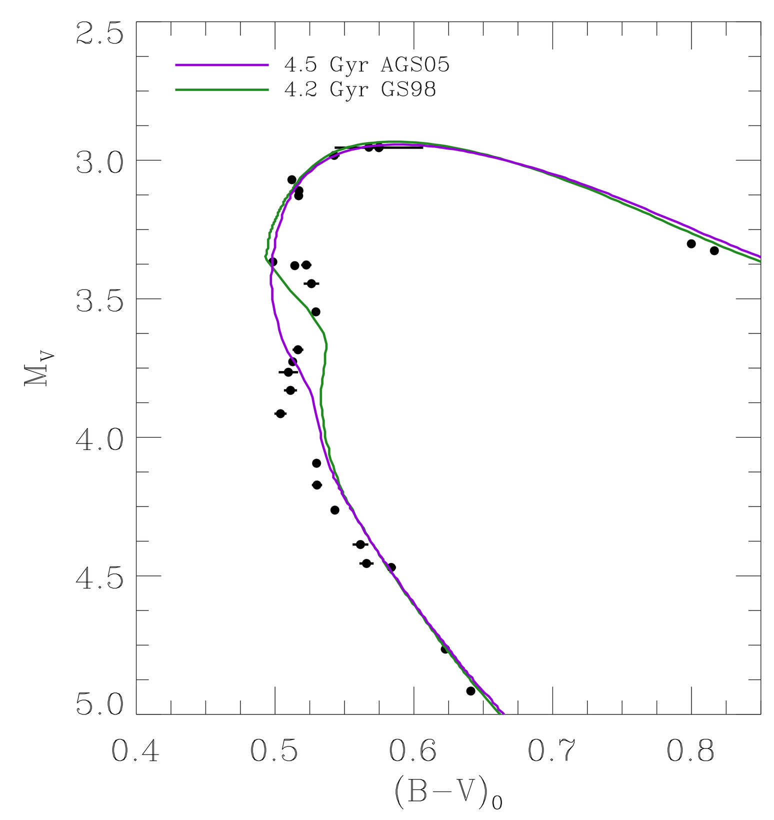

Fig. 1: CMD of M67 (Sandquist 2004) with isochrones for the two SA AGS05 and GS98 in agreement with **VG07**.

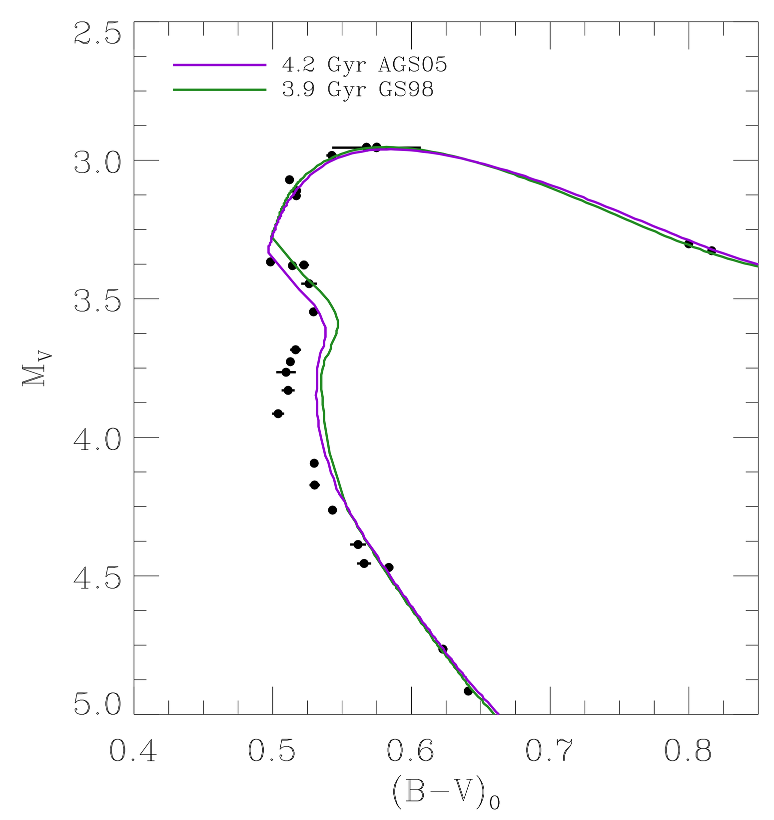

Fig. 2: Isochrone fit to M67 including **diffusion** in both solar calibration and tracks for M67 ; no overshooting was considered.

Inclusion of diffusion

As already mentioned by VG07, the inclusion of atomic diffusion (AD) leads to an enrichment of heavier elements in the core over time due to **gravitational settling**. This in turn supports the occurrence of a CC, so that now both SA have the same TO morphology, as given in Fig. 2. Since M67 has a similar age as the Sun (4.57 Gyr), AD is also mandatory in order to fit the helioseismic inferences correctly. The same results were already made by Michaud et al. 2004, they could match the TO of M67 by just including AD.

Overshooting

VG07 needed to include a small amount of overshooting (OS). OS extends the border of the CC due to the **non-zero inertia** of the up-flowing material. When a small CC is already present, OS can increase its size such that the TO morphology can be altered considerably (see Fig. 3) depending on the respective amount of OS and its implementation. It should be stressed that both with its free parameter cannot be taken as granted, since OS is still a subject of current research.

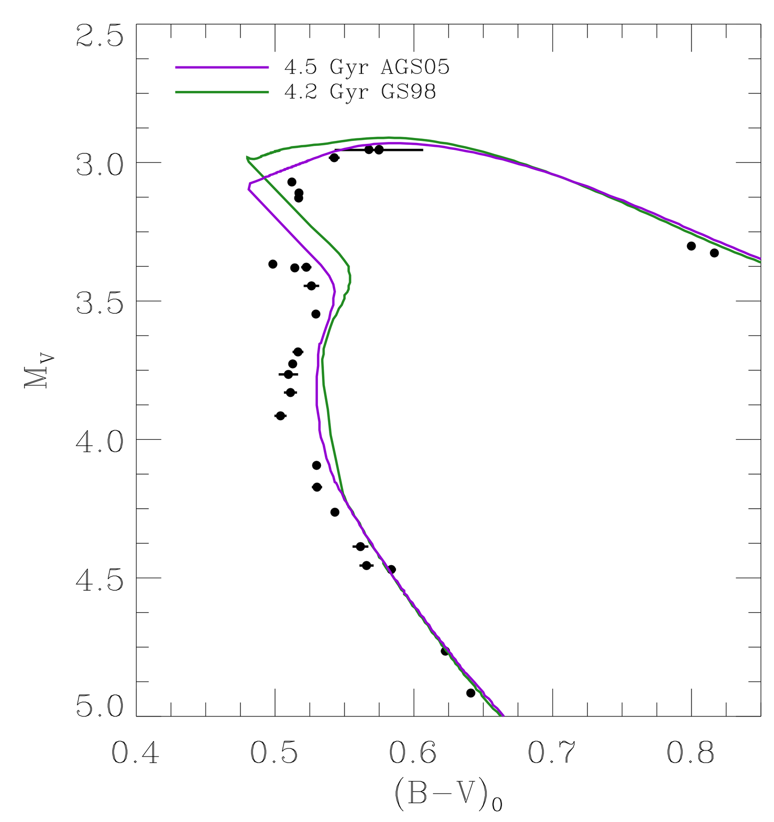

Fig. 3: Isochrone fit to M67 with **overshooting** taken into account; no diffusion was considered.

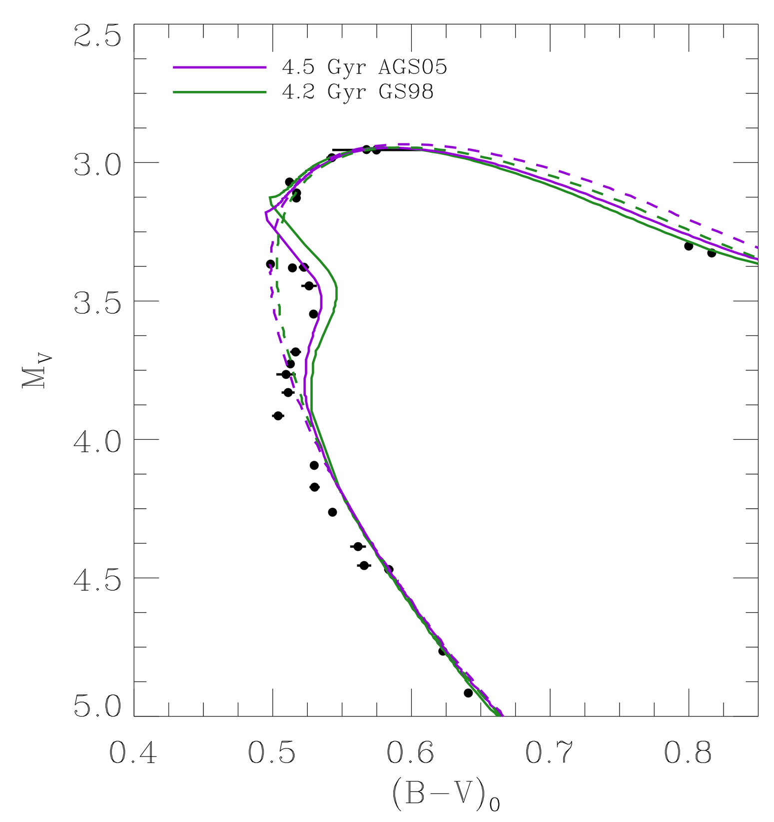

Fig. 4: Isochrones with updated **nuclear reaction rates** (dashed) and including also both diffusion and overshooting (solid).

Nuclear reaction rates

We considered the influence of the nuclear reaction rates as well, in particular the important **"bottle neck" rates** $^{14}N(p,\gamma)^{15}O$ and $^{17}O(p,\alpha)^{14}N$. New lab measurements (Marta et al. 2008, Moazen et al. 2007) have revised the former rate by almost a factor of two compared to the NACRE rate (Angulo et al. 1999). Now both SA show no sign of a CC, since the CNO-cycle depends also on the reaction rates. Only after taking AD and OS into account, the TO morphology of M67 can be reproduced for **both** SA, see Fig. 4. Nevertheless, we note that for GS98 it is easier to do so.

Comparison with other codes

At last, we compared our findings with two other independently developed stellar evolution codes (**LPCODE, Dartmouth**). In Fig. 5, it can easily be seen that models with both codes show a very similar evolution along the HRD; differences are hardly noticeable. Therefore, the isochrones are correspondingly of a similar quality, as shown in Fig. 6, which holds also for other choices of constitutive physics. We can rule out any systematical uncertainties and the conclusions of our work are assured.

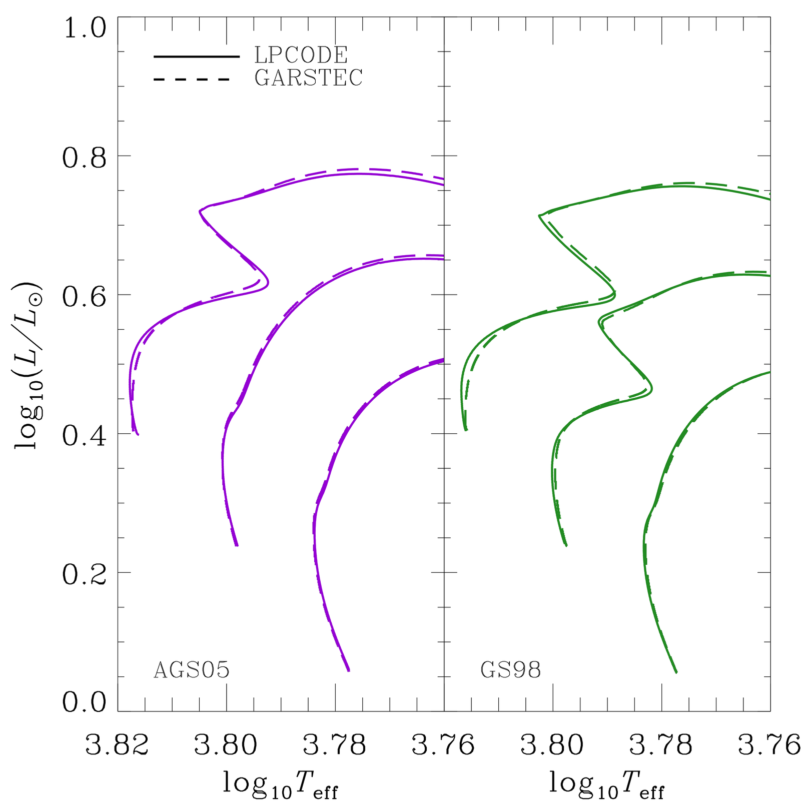

Fig. 5: Comparison between **LPCODE** and GARSTEC. Here, tracks (1.1, 1.2, and 1.3 $M_\odot$) used for Fig. 4 are shown.

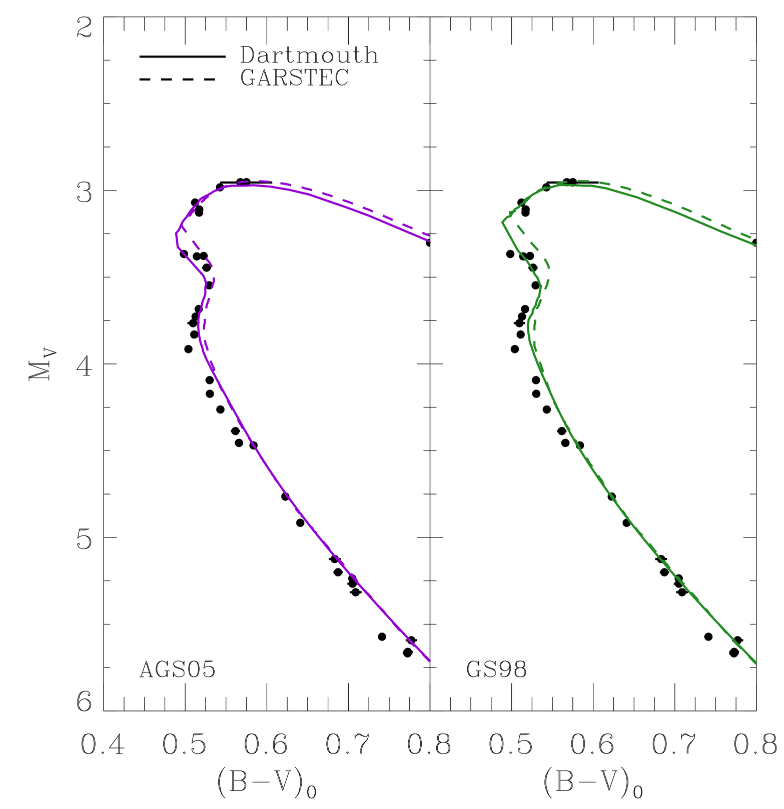

Fig. 6: Comparison between the **Dartmouth** code and GARSTEC. CMDs of M67 showing the same isochrones from Fig. 4.

Conclusions

We find that using the new SA makes it more difficult to reproduce M67. This result is in agreement with results by VandenBerg et al. However, changes in the constitutive physics of the models, particularly overshooting, can influence and alter this result to the extent that isochrones constructed with models using low CNO SA can also reproduce the TO morphology in M67. We conclude that only if all factors affecting the TO morphology are completely under control (and this is **not the case**), M67 could be used to put constraints on SA.

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P-24 Impact of CR / X-ray ionization on the SMBH formation

Kyoto University. K.Inayoshi & K.Omukai

2nd generation stars formation from **metal-free gas** irradiated with extragalactic **radiations**

- Far UV radiation ($J_{\rm UV} \geq J_{\rm crit}$)

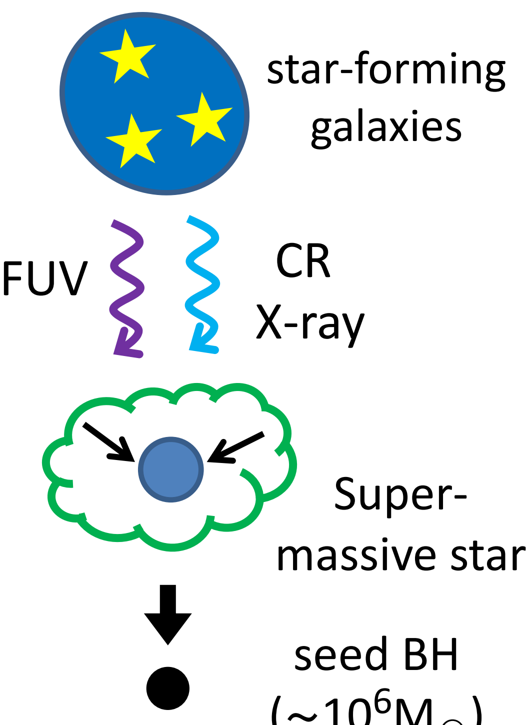
—— **Supermassive stars** (~$10^6 M_\odot$) formation **!**

⇨ the seed BHs of SMBHs (~$10^9 M_\odot$) @z>6

- ionization effects such as **CR** and **X-ray**

—— the enhancement of the critical flux $J_{\rm crit}$

⇨ extremely strong FUV flux is not realized

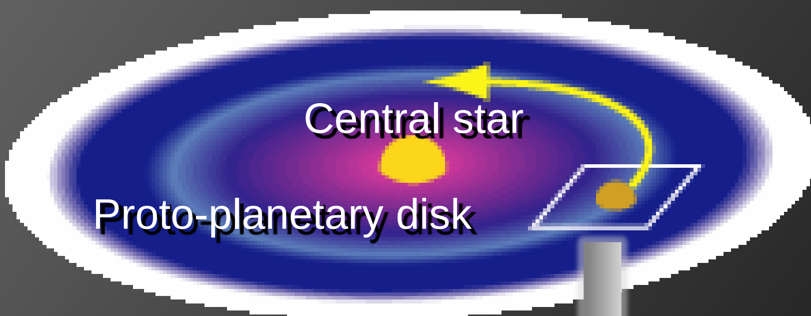


We discuss the nature of radiation sources needed for SMBH formation, considering CR and X-ray ionization feedback

GAS ACCRETION ONTO CIRCUM-PLANETARY DISKS

CPS Center for Planetary Science

Tanigawa Takayuki (CPS / Hokkaido Univ.),
Ohtsuki Keiji (CPS / Kobe Univ.), Machida Masahiro (NAOJ), and Kobayashi Hiroshi (Jena Univ.)



Satellite systems around giant planets

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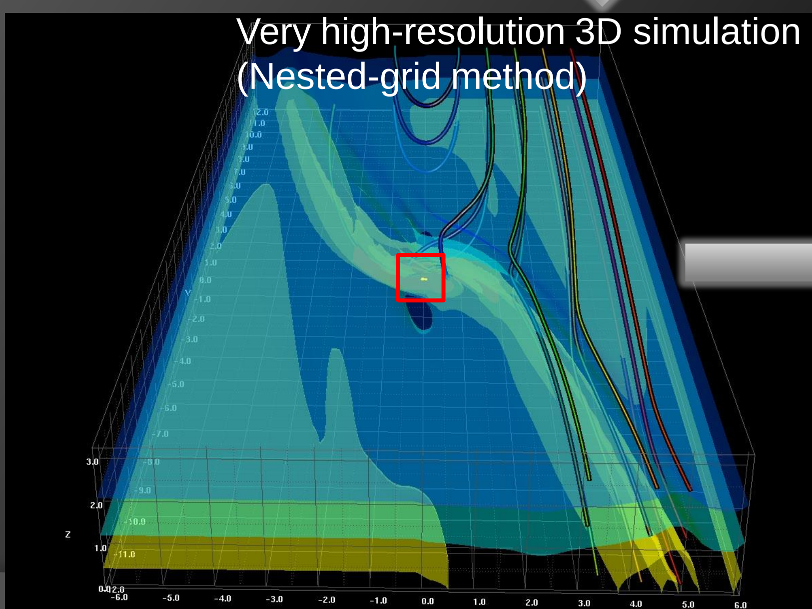
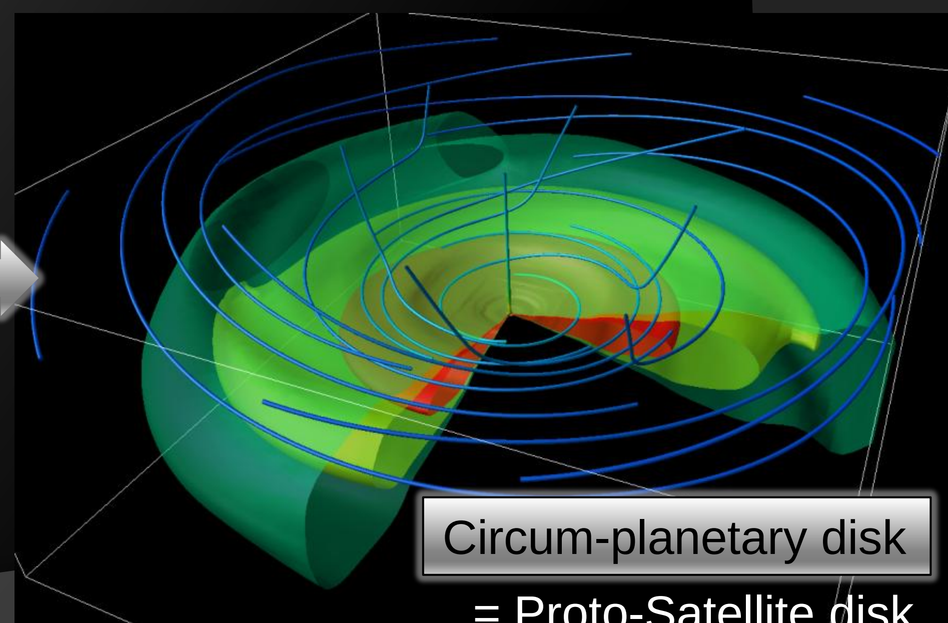
Formed in circum-planetary disks





Title:

Search for unknown exoplanets by detection of transit timing variations

Author:

Sho Manabe (Presenter), Yoichi Itoh

Abstract:

The exoplanets of about 500 have been detected up to the present time. And, those majorities are gas-giant planets. Here, we are interested in the search for terrestrial planets.

In fact, known exoplants of about 90% have been detected by the radial velocity (RV) method. However, if our sun is observed from the outside of the solar system by the RV method, planets that is lighter than the Jupiter and the Saturn will not be detected for the detection limit of the RV method. To detect these plantes lighter than the Jupiter and the Saturn, that is undetectable terrestrial exoplanets in other planetary systems, we should use another observation method.

We have made observations by the transit timing variation (TTV) method. In the TTV method, there is potency to detect lighter exoplanets than the RV method. It is forecast that the transit periods of known transit planets will not be constant, if there are additional planets in the already known transit planetary systems. Therefore, we can detect additional planets, by making many transit observations and by detecting the transit timing variations.

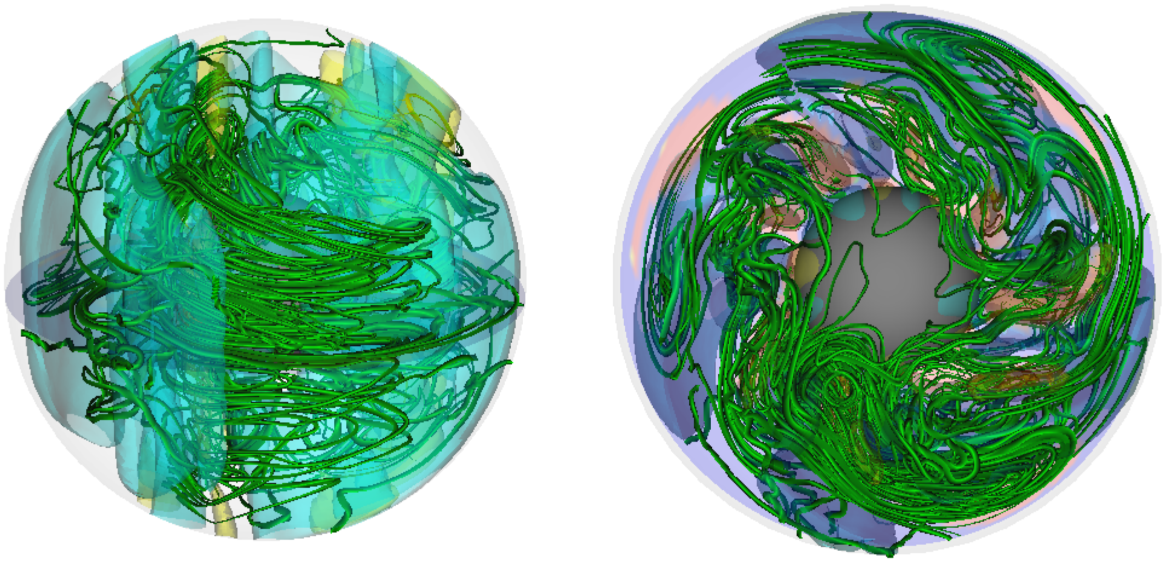
In our poster presentation, we will make a presentation about the results of our TTV observations up to this time.

IMF is one of the important ingredients on the formation and evolution of galaxies. Komiya et al.(2007) deduced that extremely metal poor(EMP) stars had a high-mass IMF with the median mass of 5-20Mo from the statistics of carbon enhanced EMP stars This indicates there should be a changeover of the IMF from the high-mass to the low-mass one such as observed for the spheroid components and thick disc somewhere at the in-between metallicity. On the other hand, the recent the large-scaled spectroscopy have unveiled the surface abundances for many EMP stars. The Stellar Abundances for Galactic Archaeology(SAGA) database(Suda et al.2008) compiles almost all these abundance data, which enables us the statistical analysis of the characteristics of abundaces of EMP stars. The purpose of this work is to seek for the imprints that the changeover of IMF have left in the surface abundance of elements among the sample stars of SAGA database. In this work we choose as Zn, Co and Ba as the target elements for the purpose. We find that mean abundance ratios of [(Zn,Co,Ba)/Fe] show significant breaks around [Fe/H] -2 which consistent with the imprints that the changeover of IMF predicted from the statistics of carbon enrichment around it (Suda et al. 2010). Since the variations of supernova yields result from the mass dependence of yields when the IMF changes, we may give insights into the mass dependence of supernova yields and discuss constraints on the production sites for Zn, Co and Ba.

Weak-field dynamo emerging in a rotating spherical shell with stress-free top and no-slip bottom boundaries

Youhei SASAKI, Shin-ichi Takehiro, Kiyoshi Kuramoto, Yoshi-Yuki Hayashi

We have performed numerical experiments of MHD dynamo in a rotating spherical shell with stress-free top and no-slip bottom boundaries.



- Obtained self-sustained dynamo solutions were all weak-field type, where mean magnetic energy is one order less than mean kinetic energy.
- The weak-field dynamo solution is considered to be a new type of solution characterized by a two-layer spatial structure.

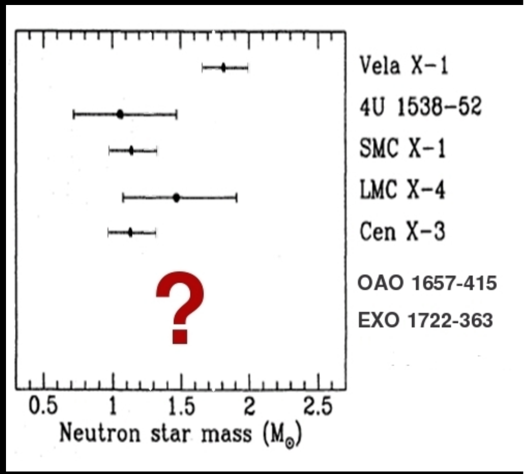
High Mass X-ray Binaries in the NIR.

Motivation.

- Maximum NS mass unknown.
- Many NS EoS theorised.

Eclipsing X-ray Binary pulsars.

- OAO 1657-415 and EXO 1722-363



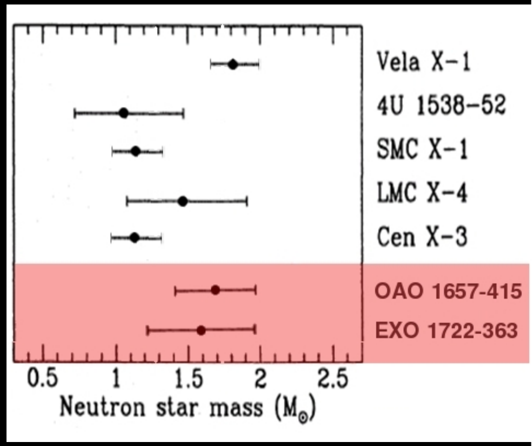
Observational Data

- 2008 multi-epoch obs. with VLT/ISAAC in H and K bands.

Spectral Classification

- EXO 1722-363 typical B supergiant B0-B1 Ia
- OAO 1657-415 is Ofpe/WN9

NS masses found



EXO 1722-363 : M_{NS} : 1.4 - 1.6 ± 0.38 $M_\odot$

OAO 1657-415 : M_{NS} : 1.4 - 1.7 ± 0.28 $M_\odot$

These are the first NS mass determinations using NIR obs.

Interior structure models of solar and extrasolar giant planets

N. Nettelmann, J.J. Fortney, U. Kramm, R. Redmer

The composition and structure of giant planets gives indications on the process of planet formation and the physical conditions of the protostellar disk where they formed from. We present interior models and thermal evolution models of giant gas planets (Jupiter), icy planets (Uranus, Neptune, GJ436b), and of the super-Earth GJ1214b. We investigate what we currently know about these planets in terms of core mass and metallicity, and discuss what would need to know in order to better constrain the models. In particular, we find that Jupiter has a small rock core of at most 5 Earth masses but is highly enriched in metals in its deep interior; Uranus and Neptune might be similar in composition but Uranus' low heat flow remains an unsolved riddle; GJ436b and GJ1214b do not contain water in an ice phase, but possibly water plasma, or be dry planets with shallow H/He atmosphere.

The Minimum Heavy Element Mass of Giant Planets, and its correlation with Stellar Metallicity

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Abstract

Planet Transit observations have revealed a population of Hot Jupiters with unexpectedly large radii. This yet undetermined physical mechanism seems to be correlated with the average stellar incident flux upon the planet. Transit observations combined with radial velocity data tell us about the mass and density of these planets, which in principle constrain the composition. However, for the large-radius planets the composition is difficult to determine because putting energy into the planet counteracts the effects of heavy elements ("metals"), which would otherwise shrink a planet.

Fortunately, a sample of transiting planets is now emerging at larger orbital distances and smaller incident fluxes that seem to be essentially unaffected by this heating mechanism. In this work we determine the interior heavy element mass for this population of less irradiated stransiting planets. There is a correlation between the stellar metallicity and the mass of heavy elements in its transiting planet. It appears all giant planets posses a minimum of ∼10-15 Earth masses of heavy elements, with planets around metal-rich stars being more metal-enriched. This relationship may provide a constraint on planet formation and evolution models.

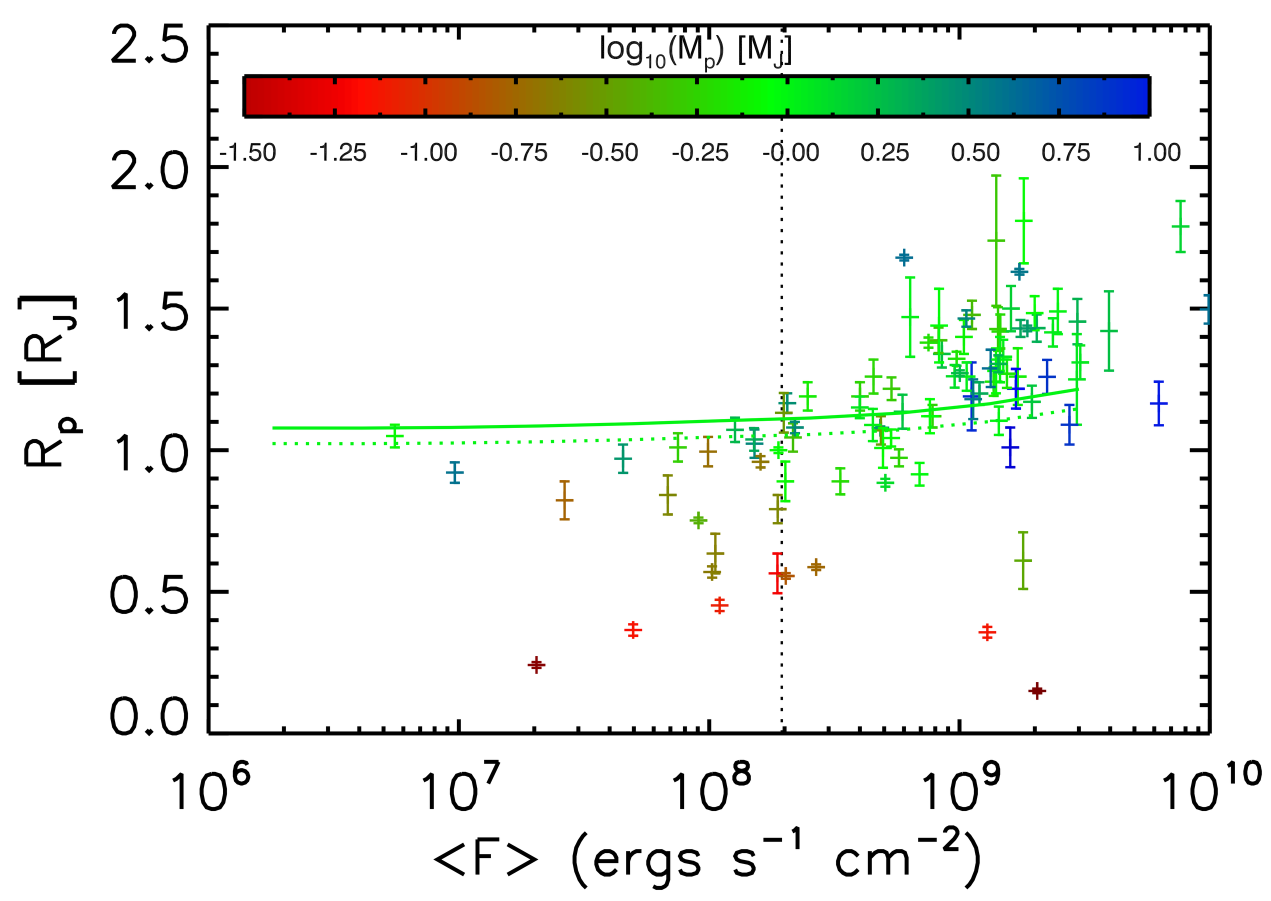

FIGURE 1: Planet radius as a function of average incident stellar flux. Planets are colored according to mass. Although the extra heating source is not certain, it is clear that it is more active at larger incident flux. We choose a cutoff of $\langle F \rangle < 2 \times 10^8$ ergs s^{-1} cm^{-2} in order to get the largest sample of planets before the range of radii significantly increase with increasing incident flux.

Methods

- Planets are modeled as a core of heavy element core with a Hydrogen/Helium envelope above
- Model atmosphere limits the net outflow of energy depending on incident flux [1]
- For all systems with $\langle F \rangle < 2 \times 10^8$ ergs s^{-1} cm^{-2}, the core mass is determined that fits the planet's observed radius.

We have found that when the heavy elements are homogeneously mixed with the Hydrogen and Helium this typically results in somewhat smaller planet radius and less metals are required in this model to explain a particular planet's radius.

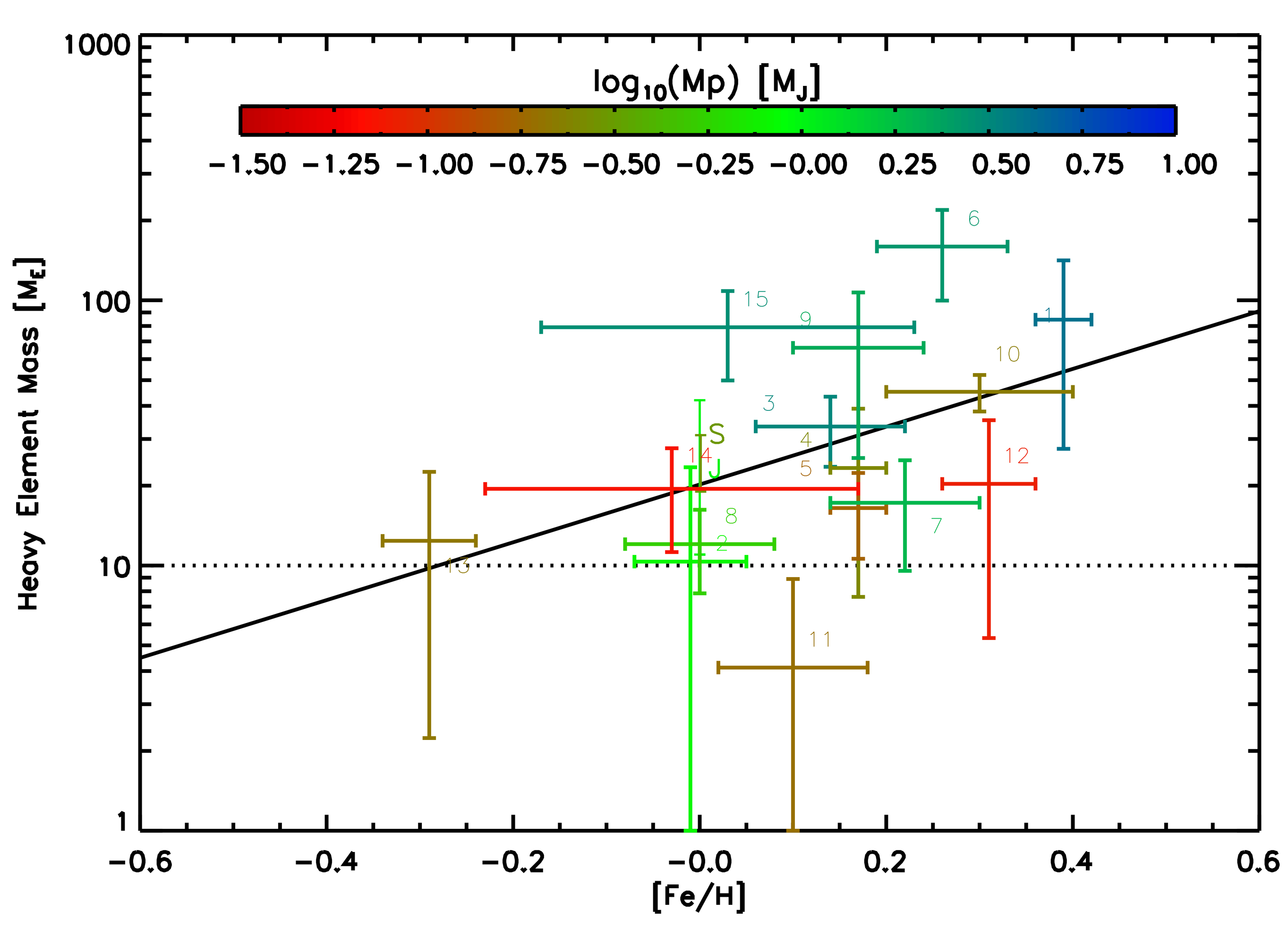

FIGURE 2: Relationship between the stellar metallicity and the model determined heavy element mass for exoplanets within our incident flux cut. Planets are similarly colored according to the planet's mass. The solid is the linear fit to $\log(M_Z)$ as a function of [Fe/H].

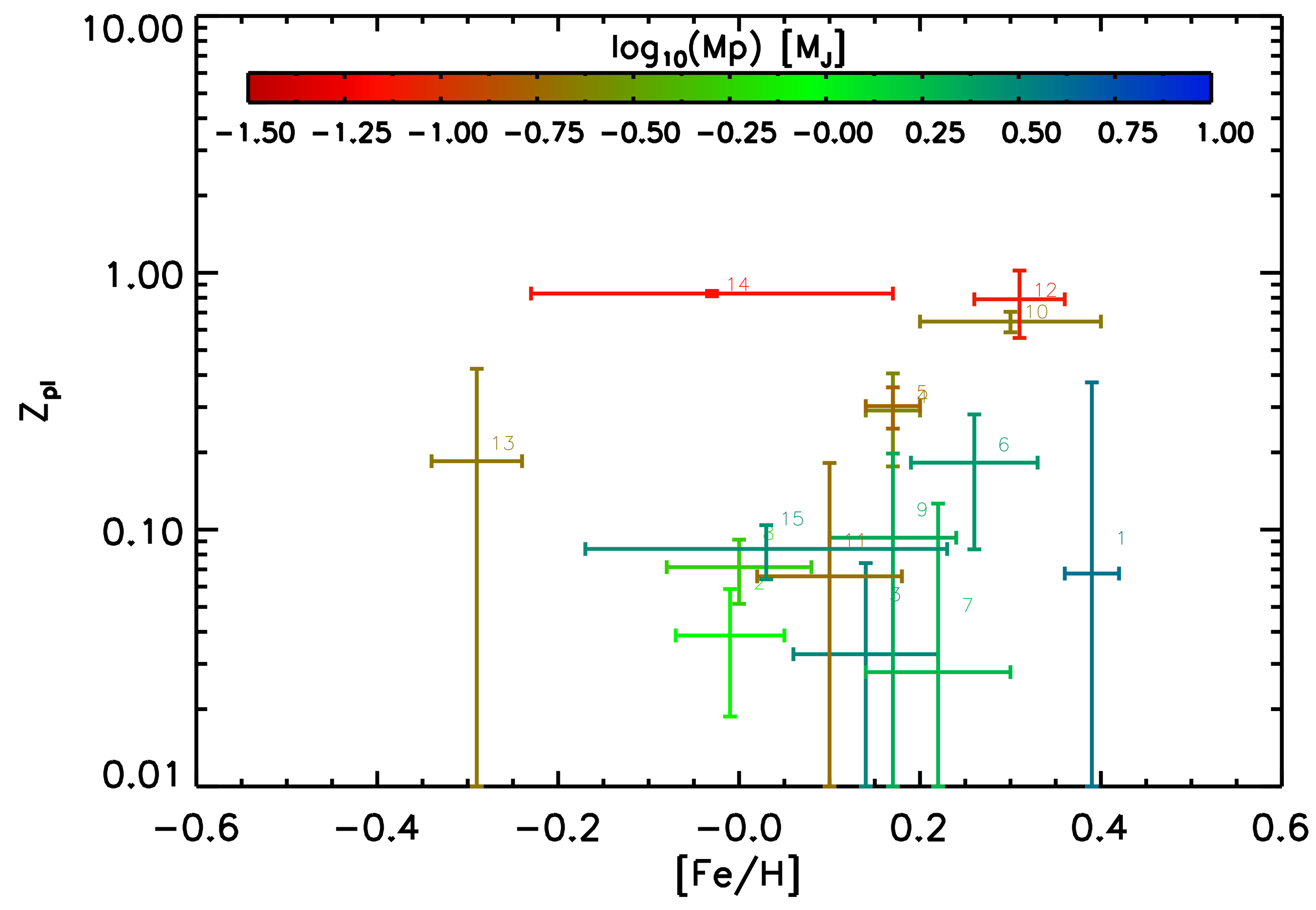

FIGURE 3: Relationship between the stellar metallicity and planet metal mass fraction. It appears that larger planets may tend to have lower metal mass fractions. Also, for a given mass planet, more metal rich systems tend to have planets with higher metal mass fractions.

Table of planet's used and their derived core mass

Number	Name	Mass	Radius	Age	$\langle F \rangle$	Core mass	References
1	HD 80606 b	3.940	1.030	7.0	1.67×10^7	81.1	[2, 3, 4, 3]
2	CoRoT-9 b	0.840	1.050	4.0	6.58×10^6	6.3	[5]
3	HD 17156 b	3.212	1.087	3.4	1.96×10^8	33.4	[6, 7]
4	Kepler-9 b	0.252	0.842	3.0	8.11×10^7	23.3	[8]
5	Kepler-9 c	0.171	0.823	3.0	3.14×10^7	14.9	[8]
6	CoRoT-10 b	2.750	0.970	2.0	5.38×10^7	159.4	[9]
7	HAT-P-15 b	1.946	1.072	6.8	1.51×10^8	17.2	[10]
8	HAT-P-17 b	0.530	1.010	7.8	8.91×10^7	12.0	[11]
9	WASP-8 b	2.240	1.038	4.0	1.79×10^8	66.2	[12]
10	CoRoT-8 b	0.220	0.570	3.0	1.22×10^8	44.7	[13]
11	HAT-P-18 b	0.197	0.995	12.4	1.18×10^8	4.1	[14]
12	HAT-P-11 b	0.081	0.422	6.5	1.31×10^8	20.3	[15]
13	HAT-P-12 b	0.211	0.959	2.5	1.90×10^8	12.4	[16]
14	GJ 436 b	0.074	0.377	6.0	4.03×10^7	19.5	[17]
15	WASP-10 b	2.960	1.080	1.0	2.10×10^8	79.1	[18, 19]

Conclusions

Previous work in determining the correlation between the metallicity of the star and the planet has required making an assumpion about the heating mechanism in order to include the large radius planets [20]. The population of less irradiated giant exoplanets emprically do are not significantly affected by the unconstrained heating source. This allows us to use the density of these objects to put a constraint on the composition without making an assumption about the heating mechanism. The mass of metals or the metal mass fraction of these planets can be compared to the metallicity of the star. It appears that most planets have at least 10 M_E of heavy elements, consistent with the core accretion formation scenario. There appears to be a tendency for planets to have more metals around stars with more metals. This developing population should provide a check on planet formation models.

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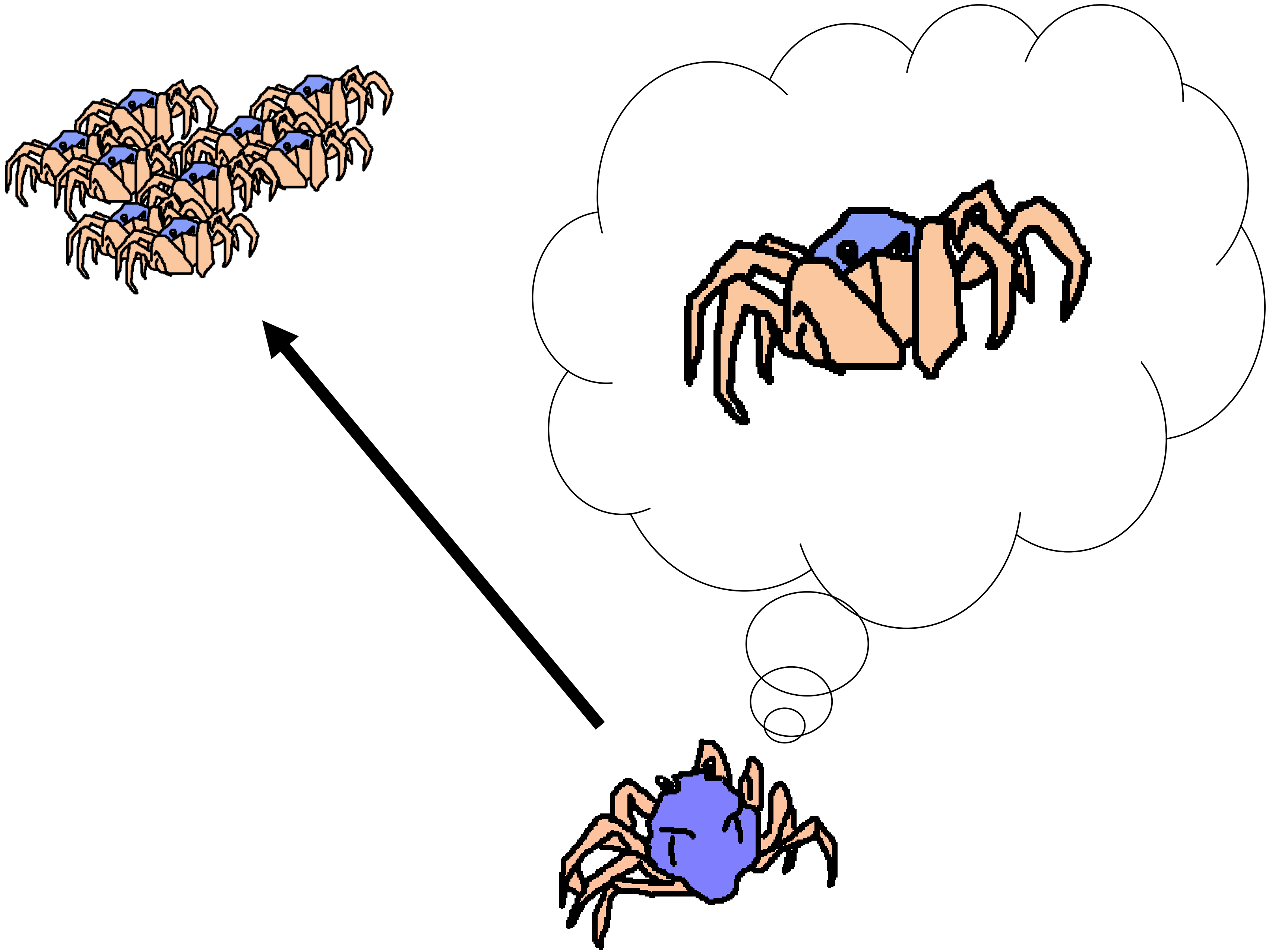

The Frequency of Hot Jupiters in the Galaxy

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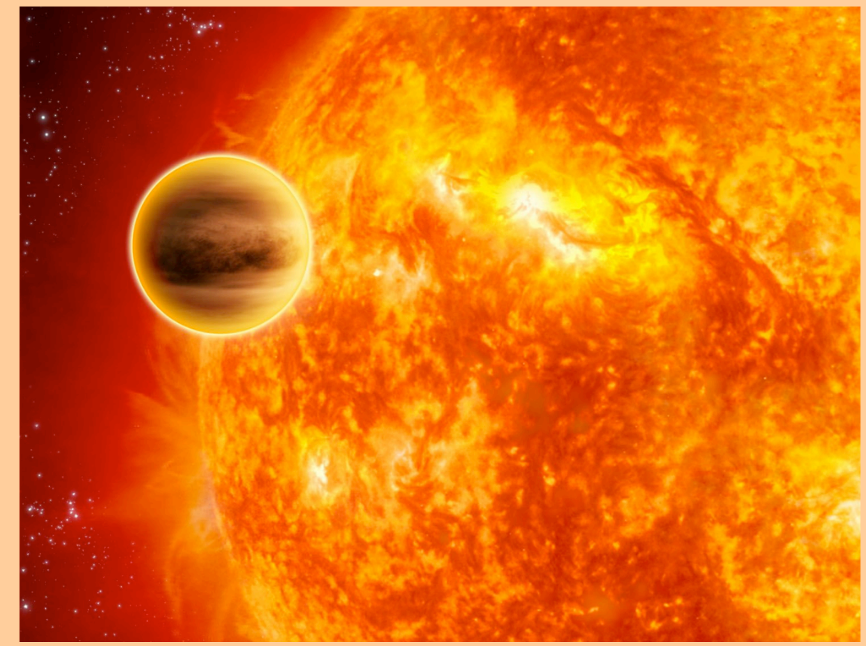
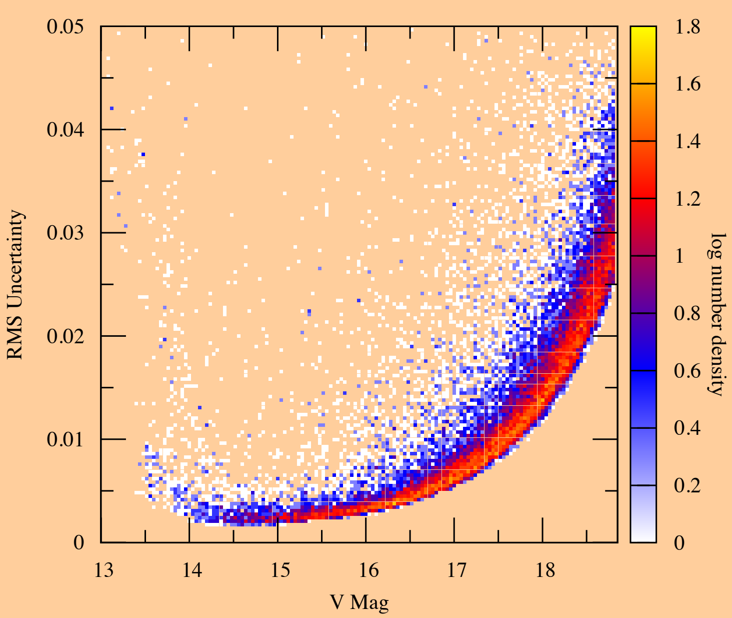


Question:

How common are Hot Jupiters in our Galaxy?

Method:

Run Monte Carlo simulations on the SuperLupus Transit Survey



Answer:

Hot Jupiters are rare!

$$f_{HJ} = 0.16^{+0.62}_{-0.10}\%$$

Theoretical instability strip of massive stars

Mélanie Godart et al.

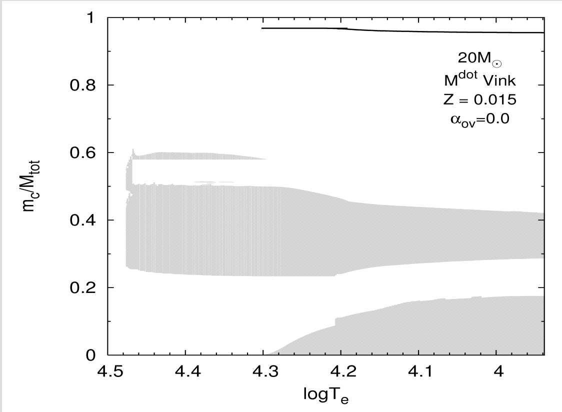
Massive stars are expected to present ß Cephei modes and SPB type modes

On the POST-MS phase radiative damping of the modes if no ICZ (Chiosi & Maeder 1986)

κ-mechanism sufficient to excite some g-modes (Saio et al. 2006)

Instability strips (κ-mechanism) on the post-MS are given by the contribution of 2 effects:

- the ICZ size
- the size of the He convective core



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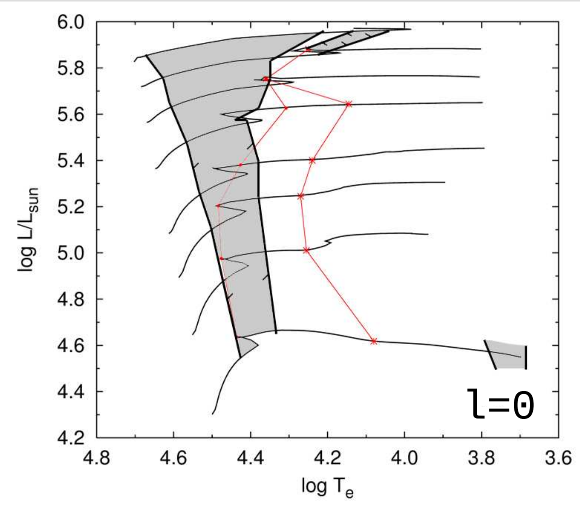

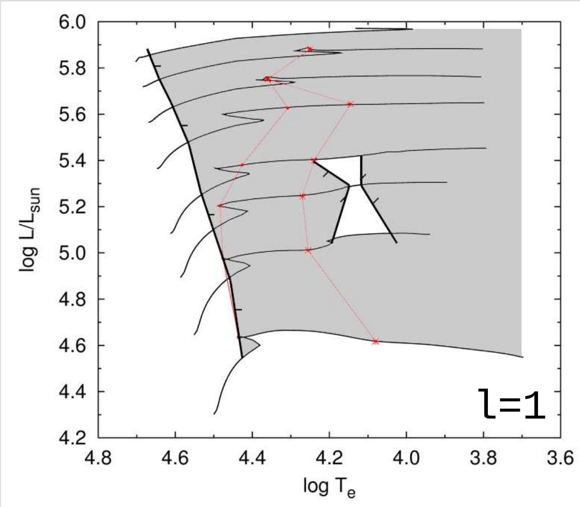

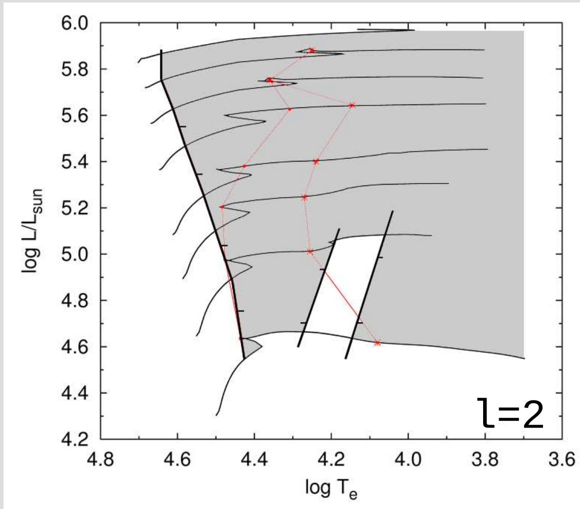

Neutron-capture and the r-process

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S. Typel, G. Martinez-Pinedo, K. Langanke
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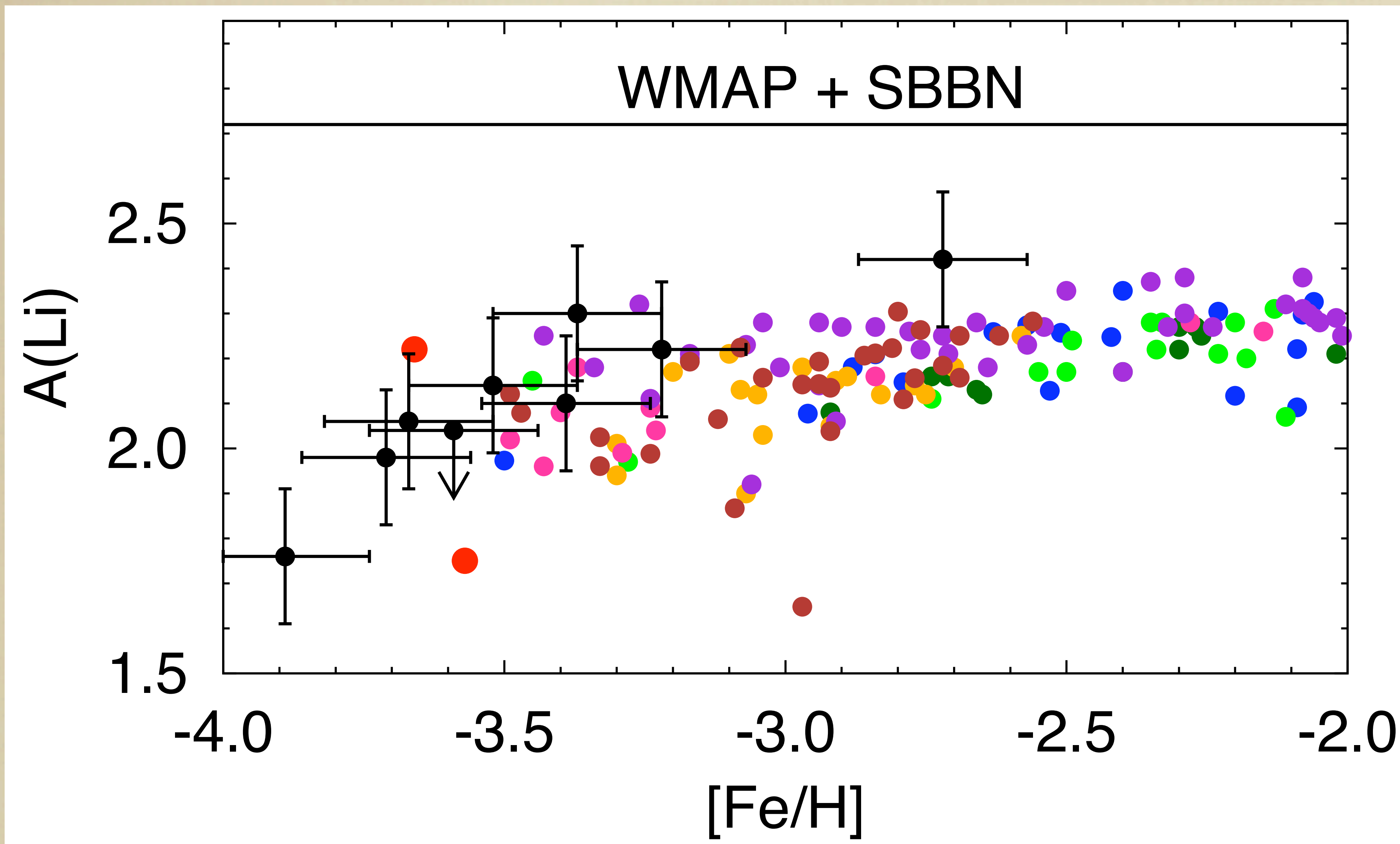
R-process is a rapid neutron-capture process which formed about a half of elements heavier than iron in the nature. This process occurs on explosive event such as Type II supernovae, but nobody has been identified its astrophysical origin unambiguously.
Neutron capture reaction consists of two component, compound process and direct-capture process. The direct capture reactions are neglected in most of previous r-process studies although it has been pointed out that direct capture reaction become dominant around r-process path.
We studied a role of direct capture reaction in the r-process using dynamical network code. The direct capture makes freeze out earlier and changes final abundances drastically because neutron-capture reaction rates change the physical condition of freeze out. Systematic studies of neutron-capture reaction rates, based on experiments and theory are strongly desired.

Lithium abundances of the most metal-poor turnoff stars

Hiroko Ito (Sokendai / NAOJ)

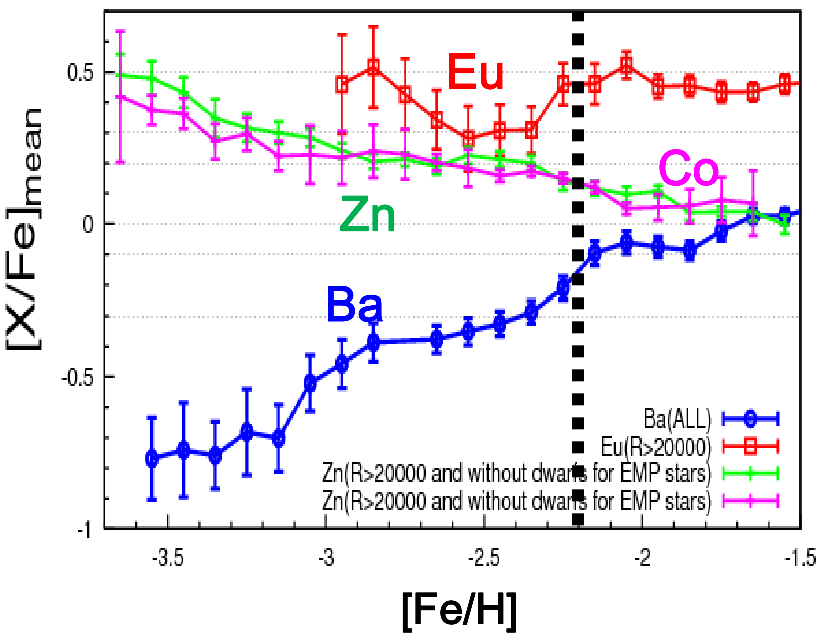


- Discrepancy between the observations and WMAP predictions
- Lower Li abundances at extremely low metallicity?
- New sample from SDSS/SEGUE
  --> high-resolution followup with Subaru/HDS
- New 5 turnoff stars in [Fe/H] ≦ –3.5

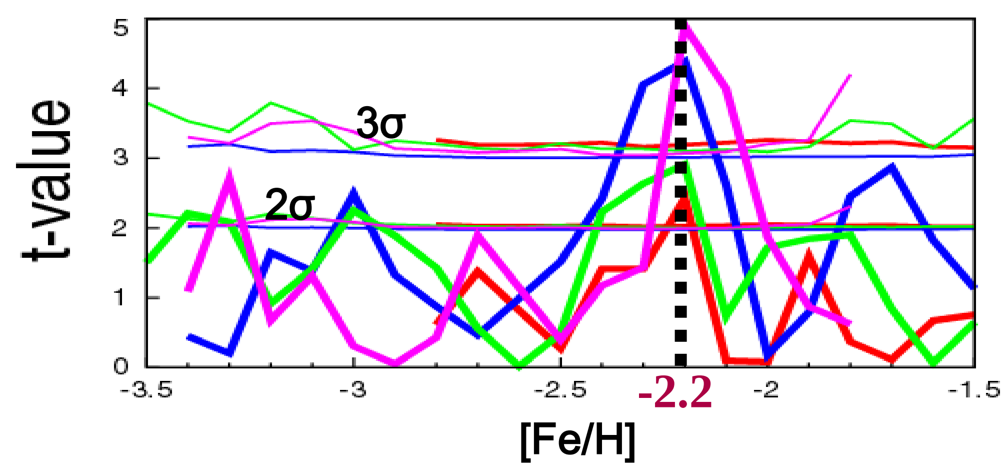
CHANGEOVER OF INITIAL MASS FUNCTION FOR GALACTIC HALO STARS AND HISTORIES OF ZINC, COBALT AND BARIUM ENRICHMENT

Shimako Yamada[1], Takuma Suda[1], Yutaka Komiya[2] and Masayuki Y. Fujimoto[1]
[1] Hokkaido University [2] National Astronomical Observatory of Japan

For the extremely metal-poor stars (EMP) in the Galactic halo, it has been shown the initial mass function (IMF) is a high-mass one with the peak mass 5-20Mo. Furthermore, such a evidence of a transition to low-mass IMF is found around the metallicity **[Fe/H]≃-2** from the statistics of **carbon**-enhanced stars . We find the mean enrichments of **zinc** and **cobalt** show two breaks around **[Fe/H]≃-2.2 and -3.3** and piecewise flat between them by utilizing SAGA database (http://saga.sci.hokudai.ac.jp/). The former break is attributable to the decrease in the average supernova yields attendant upon the changeover of IMF. The latter break is explicable by hypernovae with large explosion energy and large zinc and cobalt enrichment. We also find the same break **[Fe/H]≃-2.2** for the mean enrichments of **barium** and **europium**, which support the break is attribute to the changeover of IMF rather than to s-process enhancement.



$$\text{t-value} = \frac{\Delta\,[\text{X/Fe}]_{\text{mean}} \text{ between adjacent metallicity bins}}{\text{Standard error of } \Delta\,[\text{X/Fe}]_{\text{mean}}}$$



NUCLEOSYNTHESIS IN HIGH-ENTROPY HOT-BUBBLES OF SNE AND ABUNDANCE PATTERNS OF EXTREMELY METAL-POOR STARS (IZUTANI & UMEDA, 2010, APJL)