Velocity performance

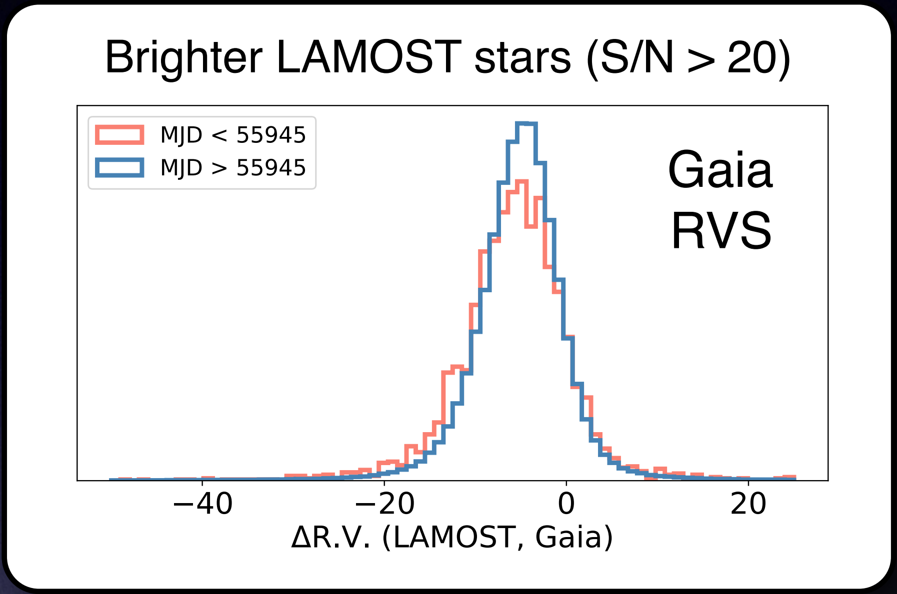
- In general LAMOST gives good parameters for millions of stars, but there are known caveats…

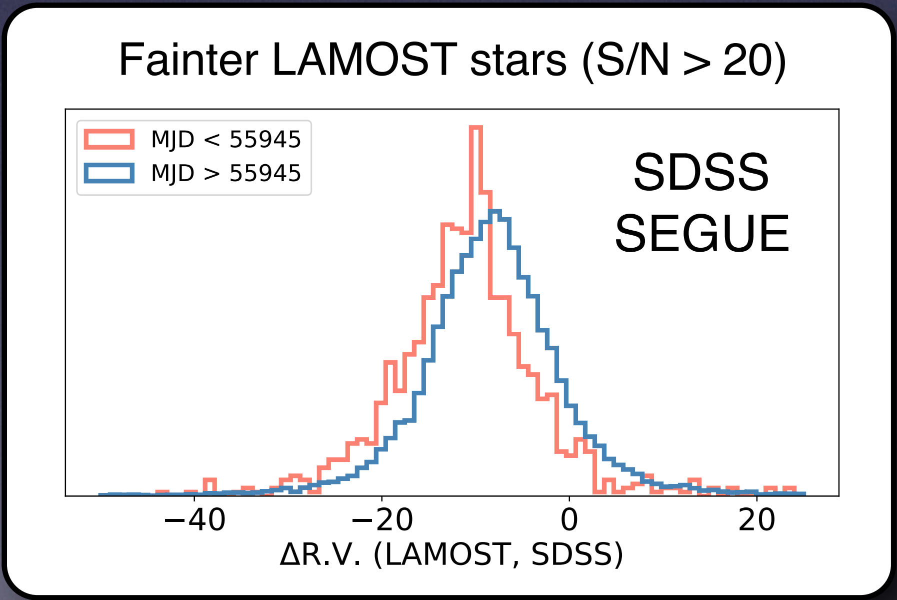
http://dr4.lamost.org/doc/The-warning

- As with SDSS, there is a mysterious untraceable velocity offset. This offset is around 5 km/s (e.g. Tian et al. 2014). A cross-match to Gaia gives offset of 5 km/s, while a cross-match to SEGUE gives 8 km/s.

- As pointed out in Boeche et al. (2018), there is a problem with LAMOST's RV calibration for the red part of the spectra prior to Sept 2012 (NB. chemistry is ok for these stars).

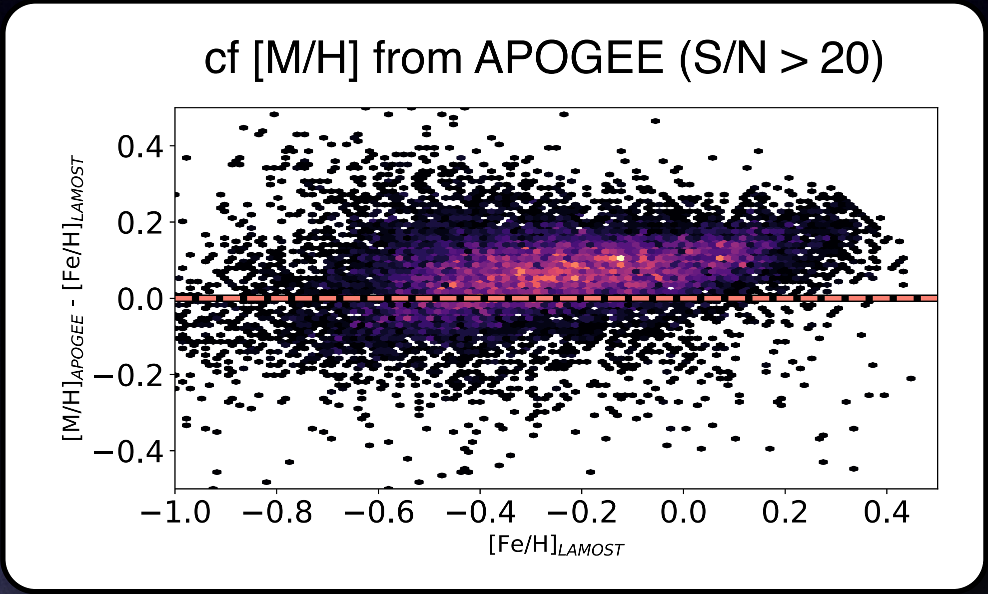
- Reported velocity errors are now reliable, at around 5-7 km/s.

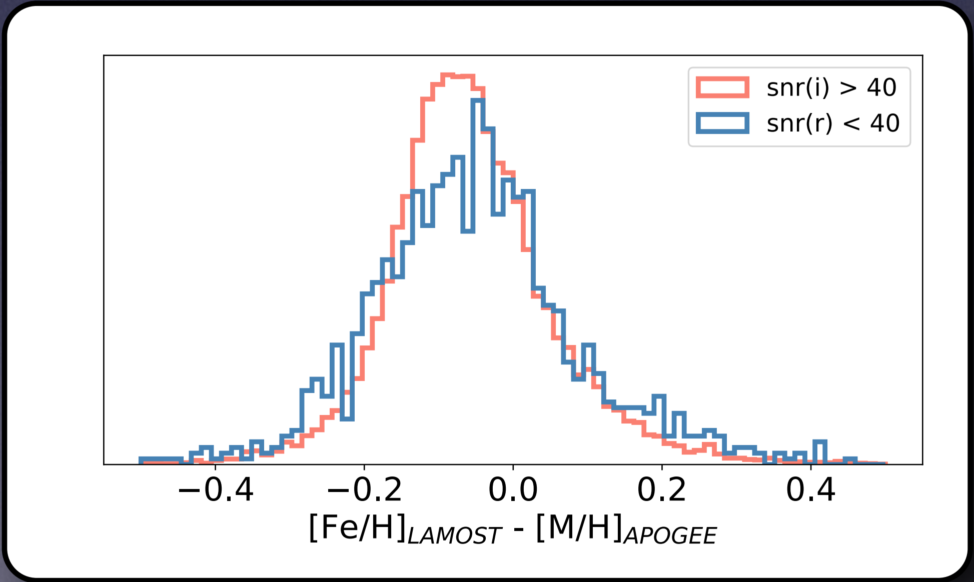




Chemistry performance

- Metallicity is harder to quantify. Here we compare the official LAMOST pipeline (LASP) to APOGEE's
- These plots show the comparison between the standard LAMOST pipeline and APOGEE. Slight offset and systematic, but that is dependence on which APOGEE metallicity you use.
- Reported LASP errors are a little too small, e.g. crossmatching to APOGEE shows that for S/N (i) > 40 the pipeline's errors should be rescaled by a factor of ≲ 1.5

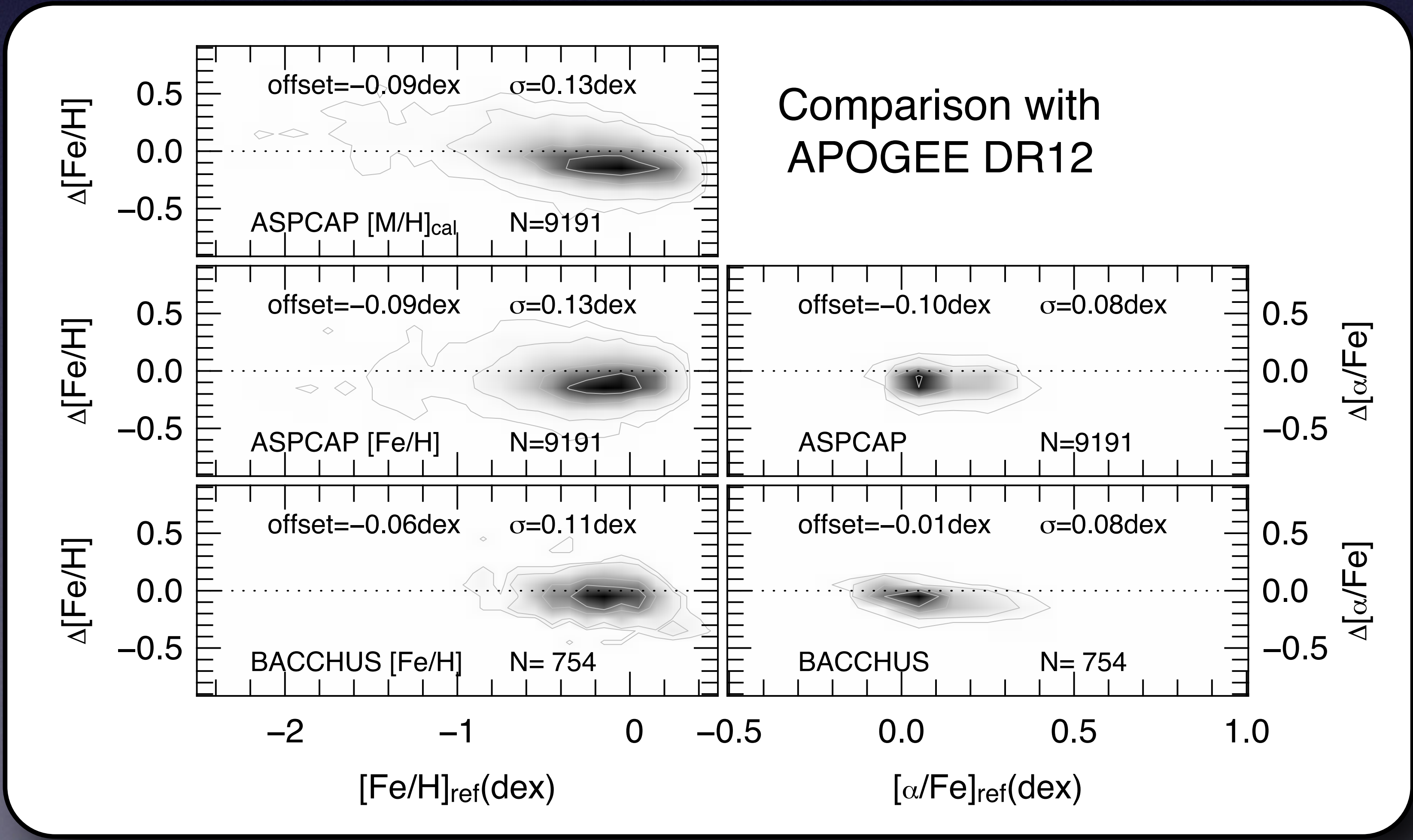




LAMOST chemistry

- Corrado Boeche applied his SP_Ace pipeline to LAMOST, which is based on general curves-of-growth method (Boeche et al. 2018)

- This provides similar precision to the standard LAMOST pipeline (LASP) but with the added benefit of reliable alpha-element abundance to ~ 0.1 dex (NB. alternative data-driven approaches exist, such as Xiang et al. 2017, Ho et al. 2017, Ting et al. 2017)



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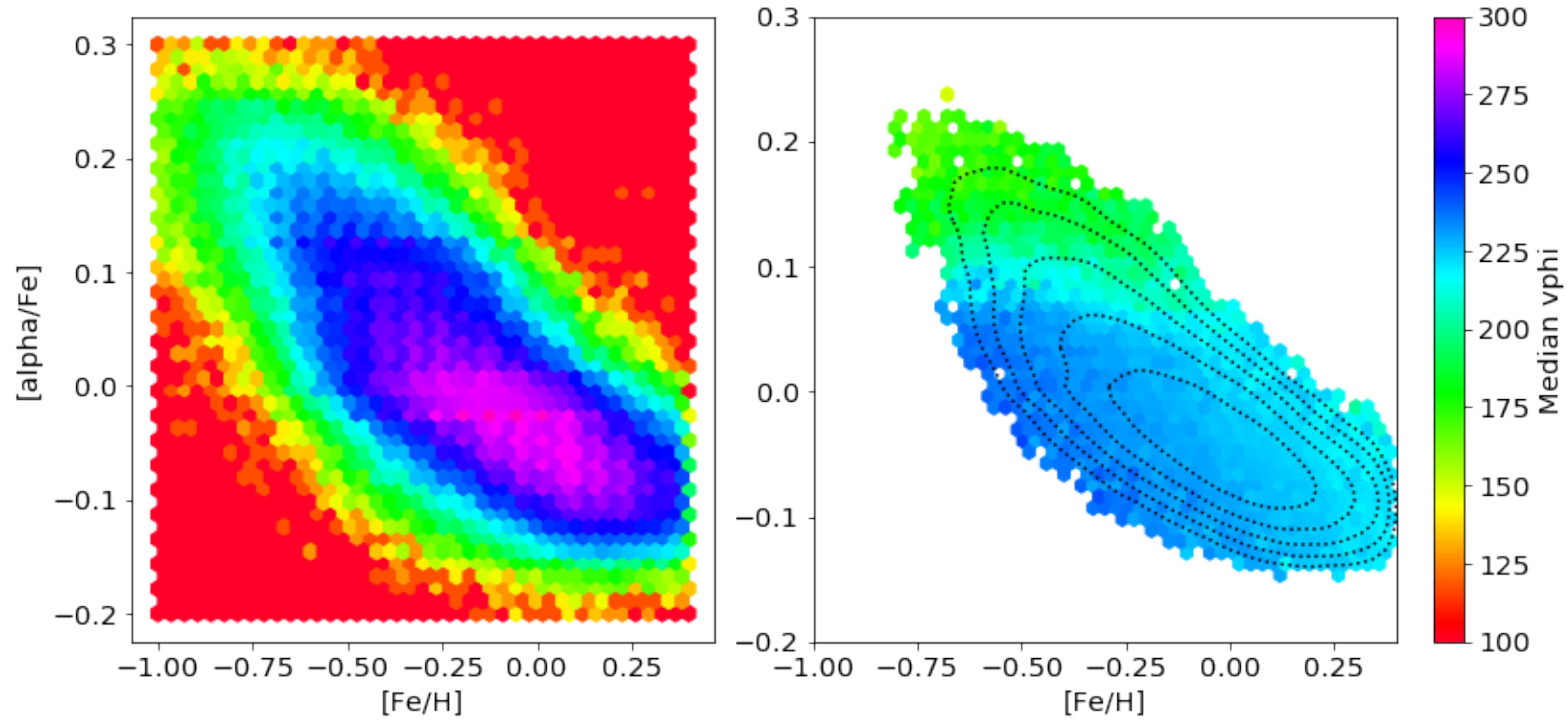
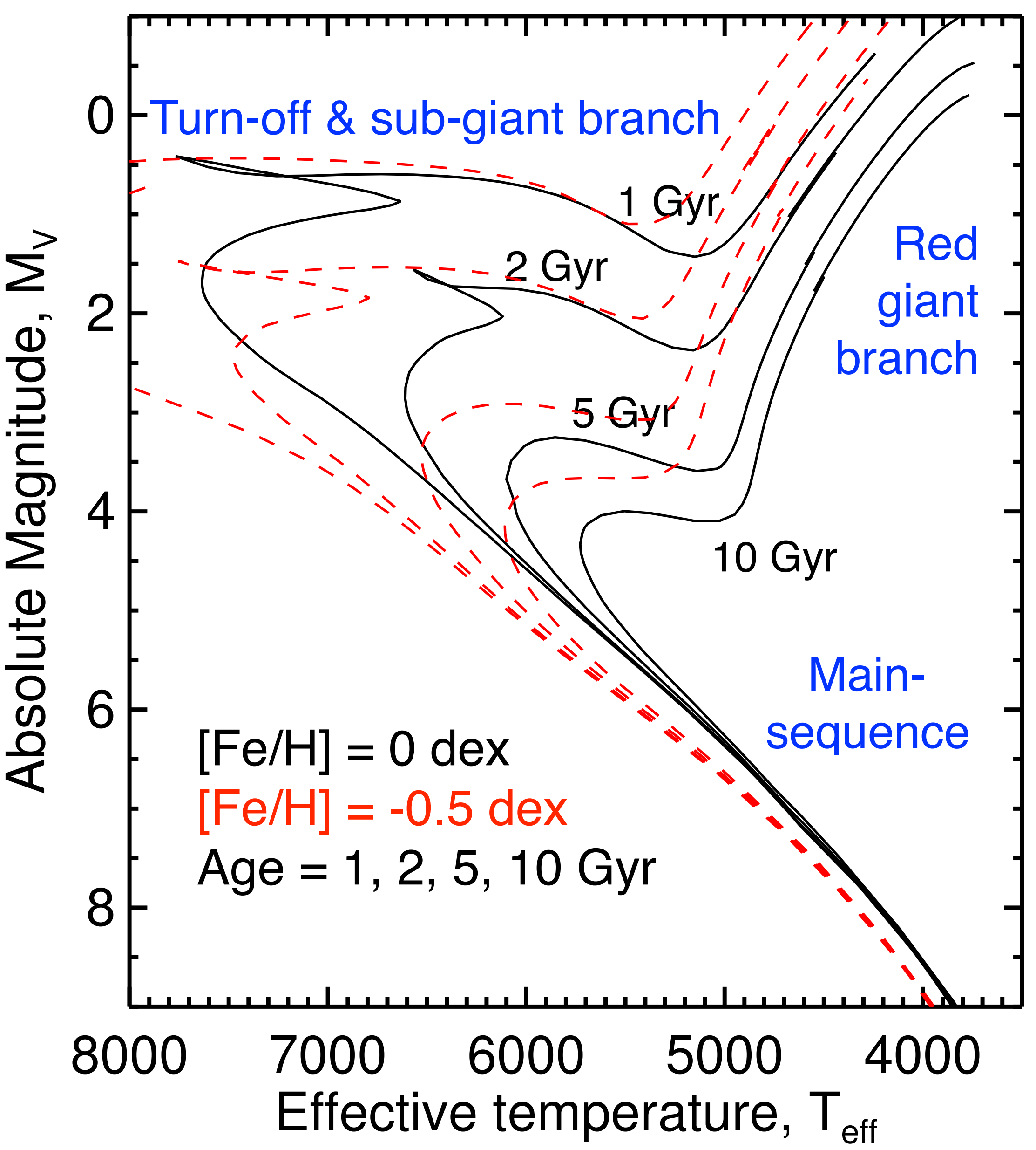


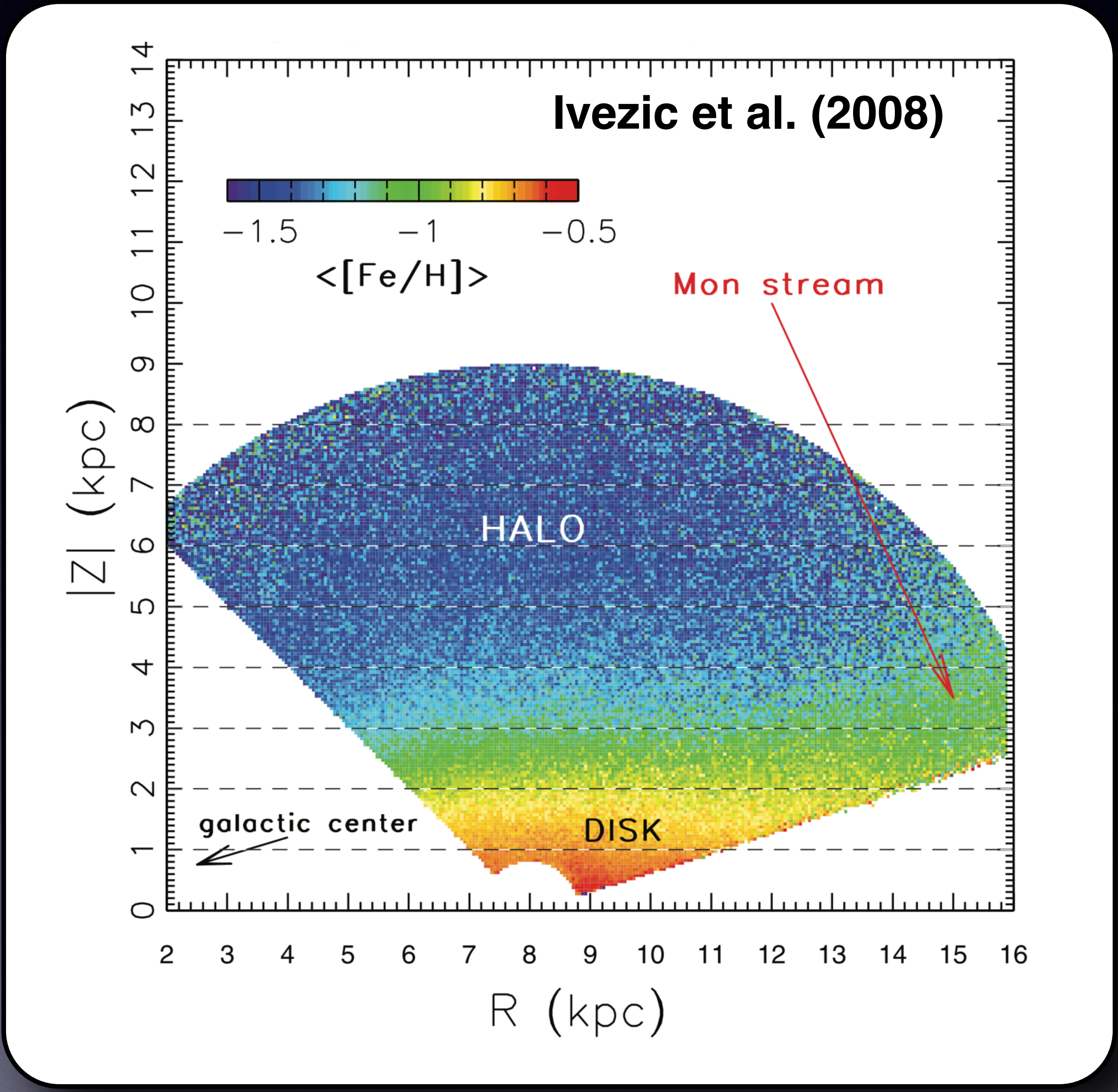
Great survey for ages

- Gaia+spectroscopy great for ages. Main-sequence stars are difficult, but good prospects for turn-off stars and giants
- Many papers using ages, such as Xiang et al. 2017, Sanders et al. 2018, Wu et al. 2018, etc…
- Created sample using 125k stars from LAMOST/RAVE + TGAS (Vickers & Smith 2018)
- Probe the chemo-dynamical evolution of the disc, looking at inside-out formation, heating and bulk flows. Now looking at radial migration.



Can we avoid spectroscopy?

- Spectroscopy is extremely useful, but it is also expensive
- For many years people have been estimating metallicities from photometry, most-effectively through the uv-excess (e.g. Ivezic et al. 2008)
- If we can estimate metallicities, why can we not estimate ages?!
- Use subset with best ages from Vickers et al. (2018) to train a random forrest regression tool to calculate ages from photometry



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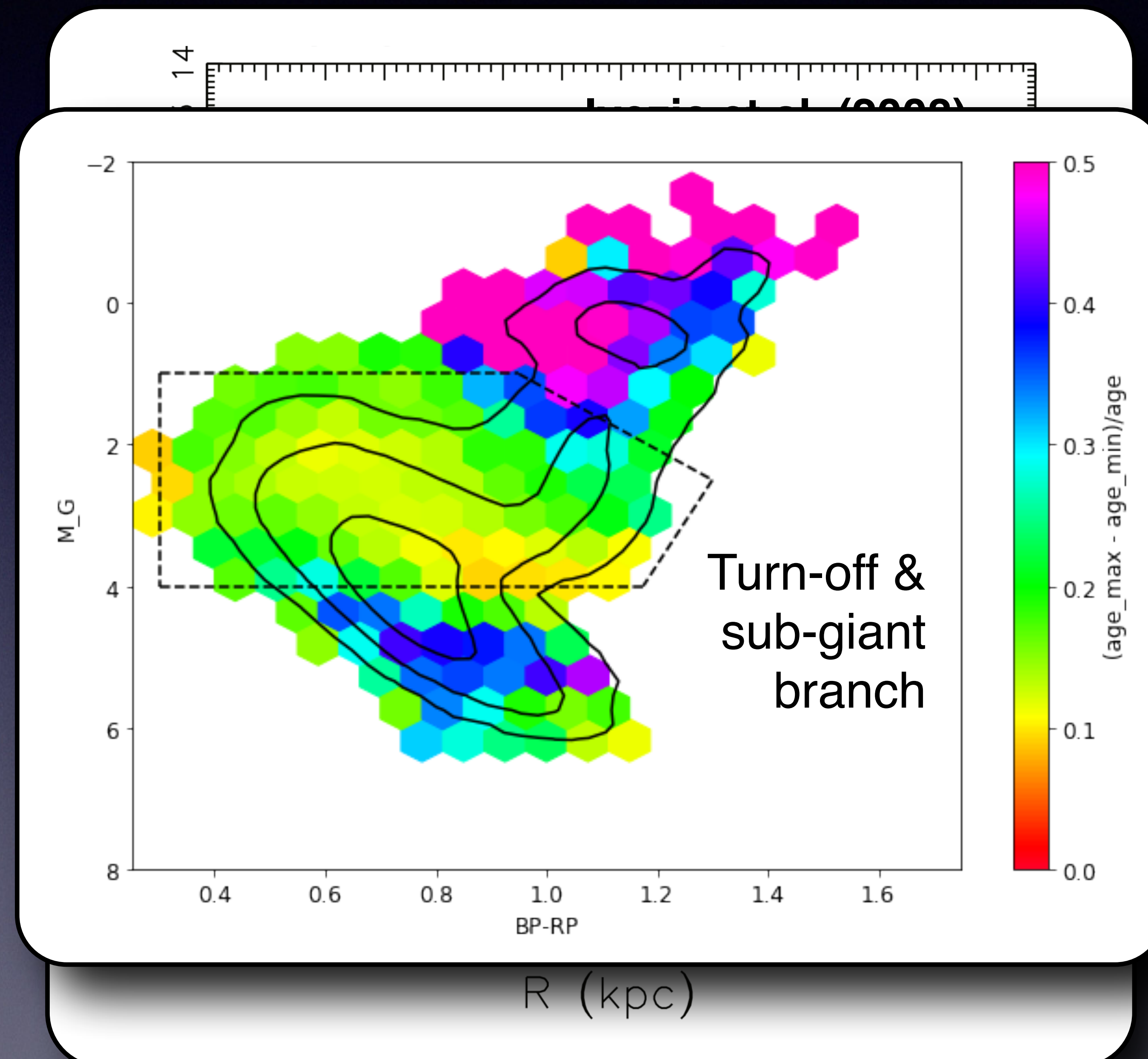
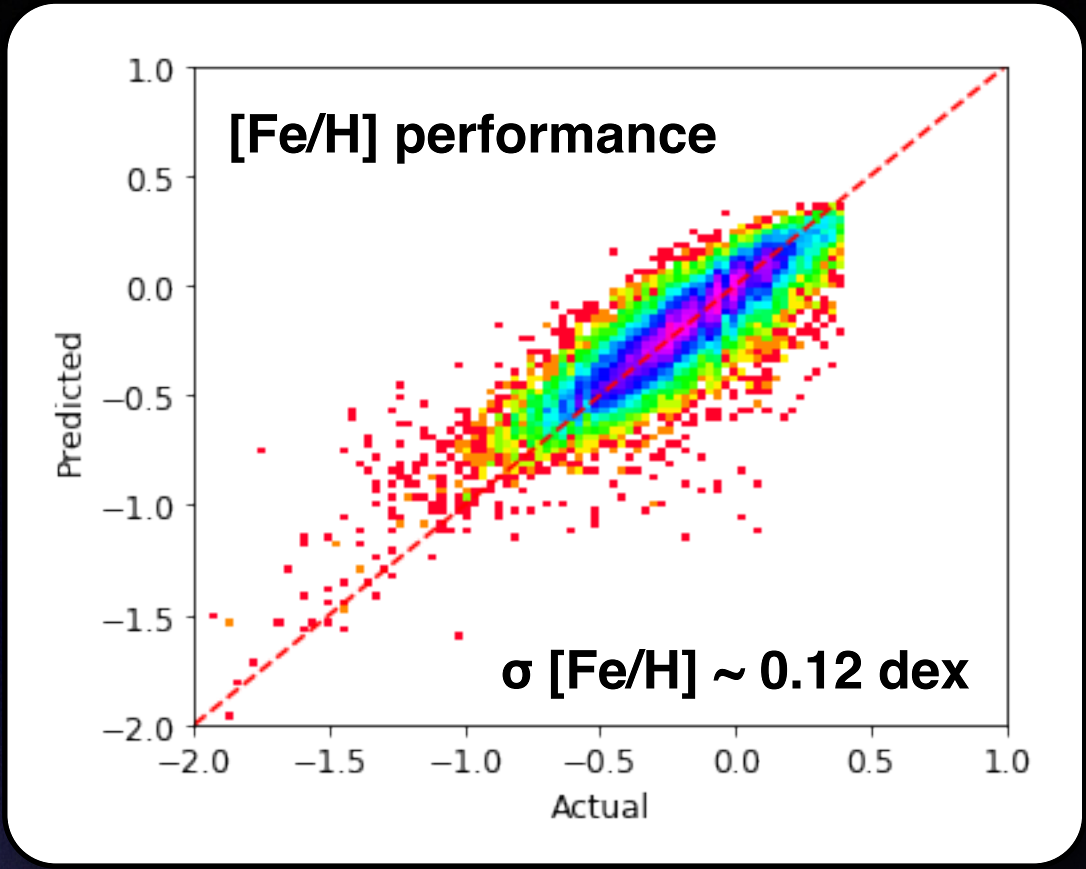
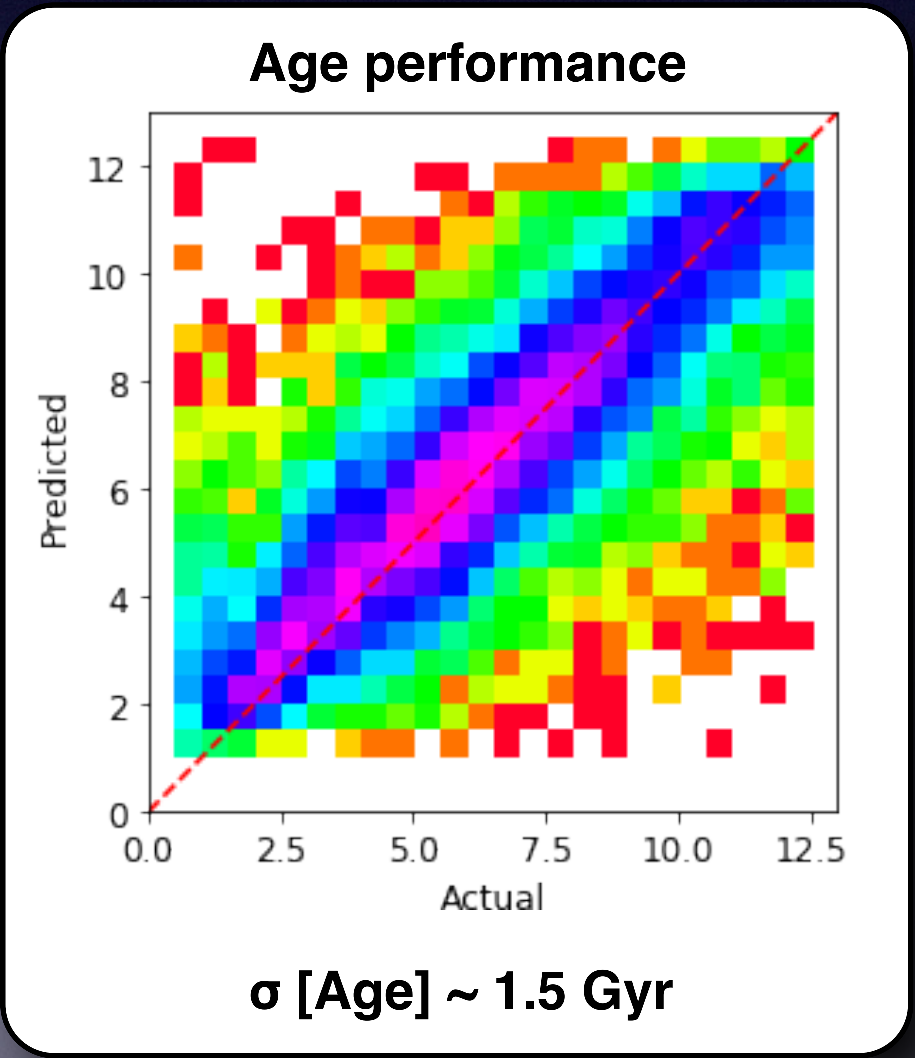
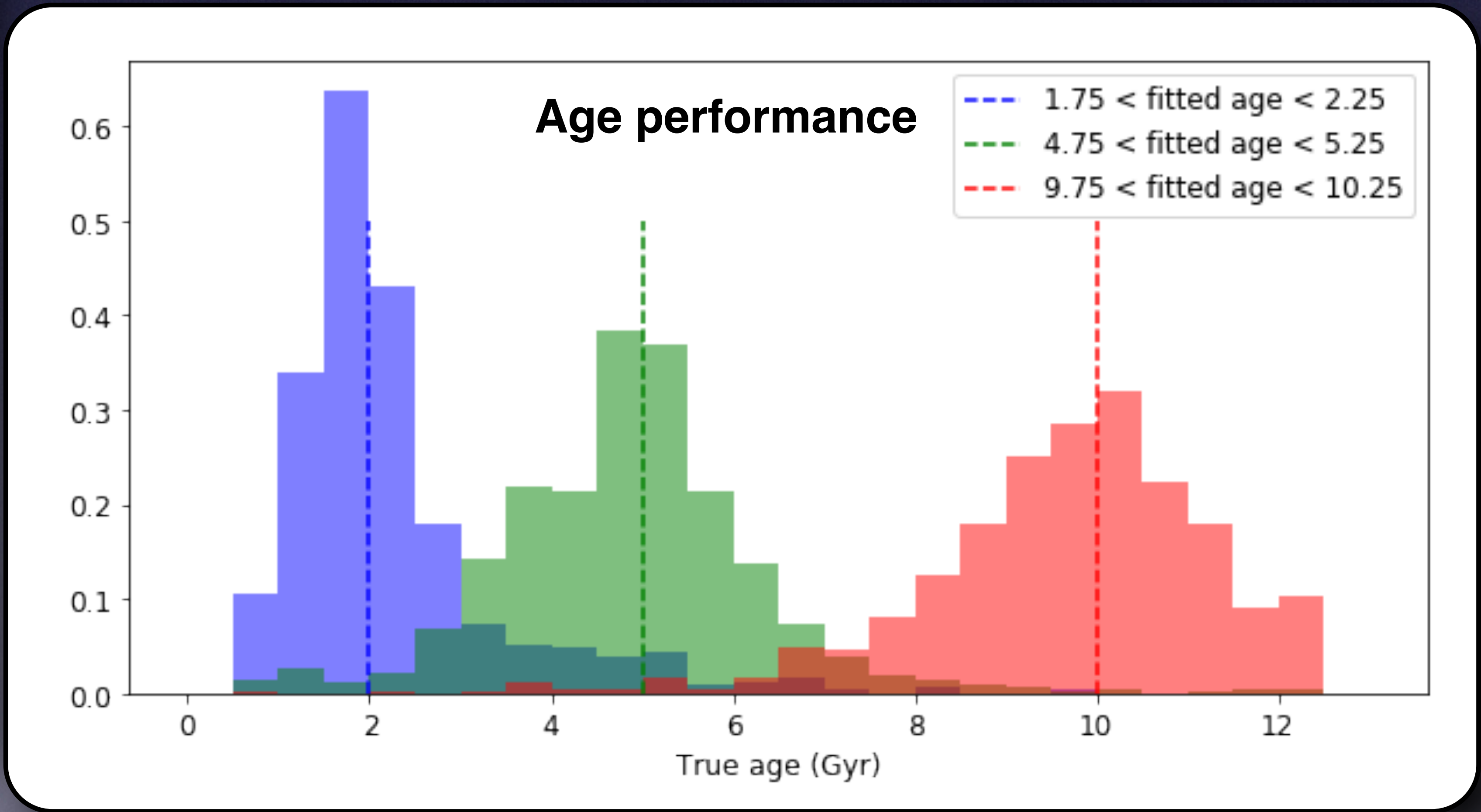


How well can we recover metallicities and ages?

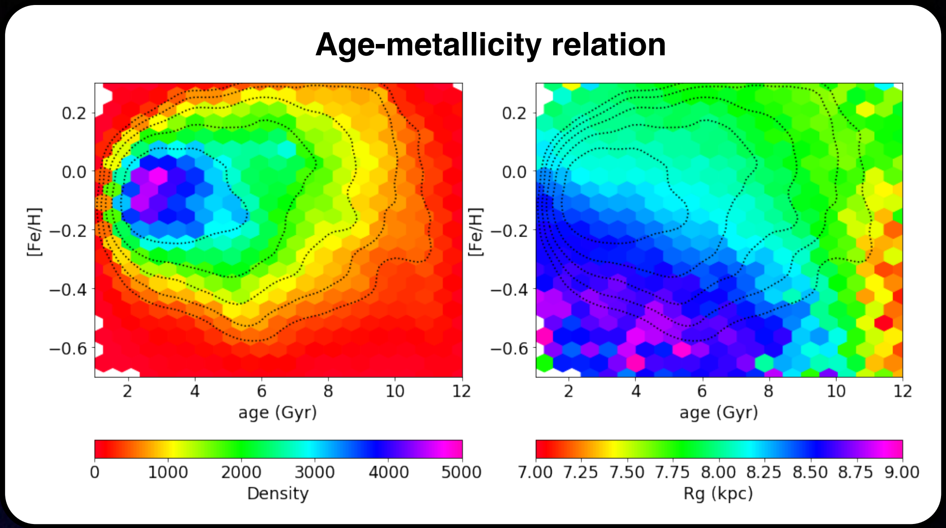


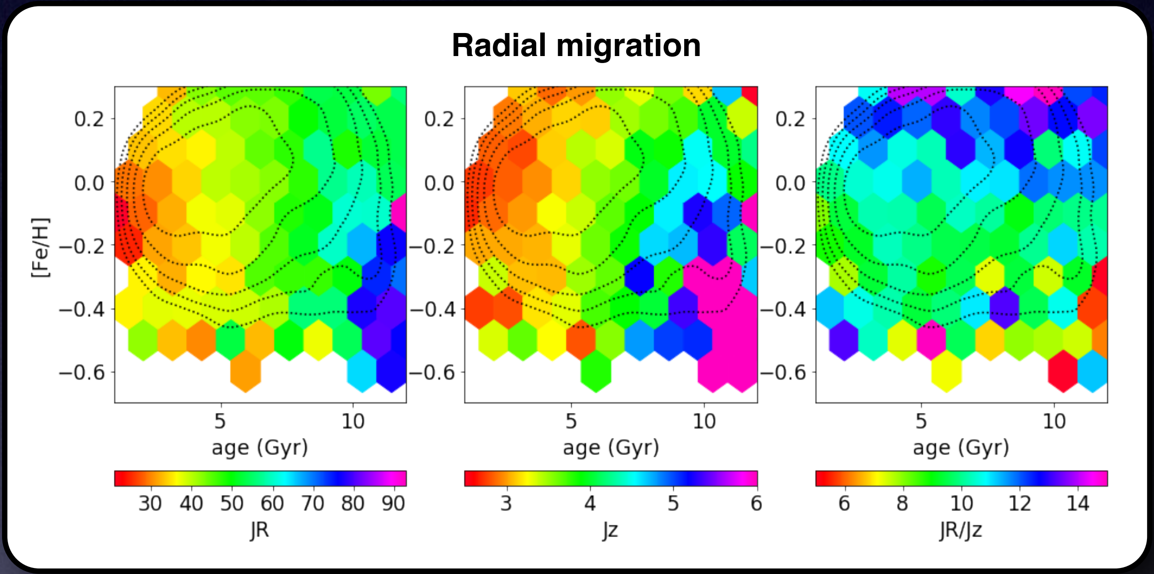


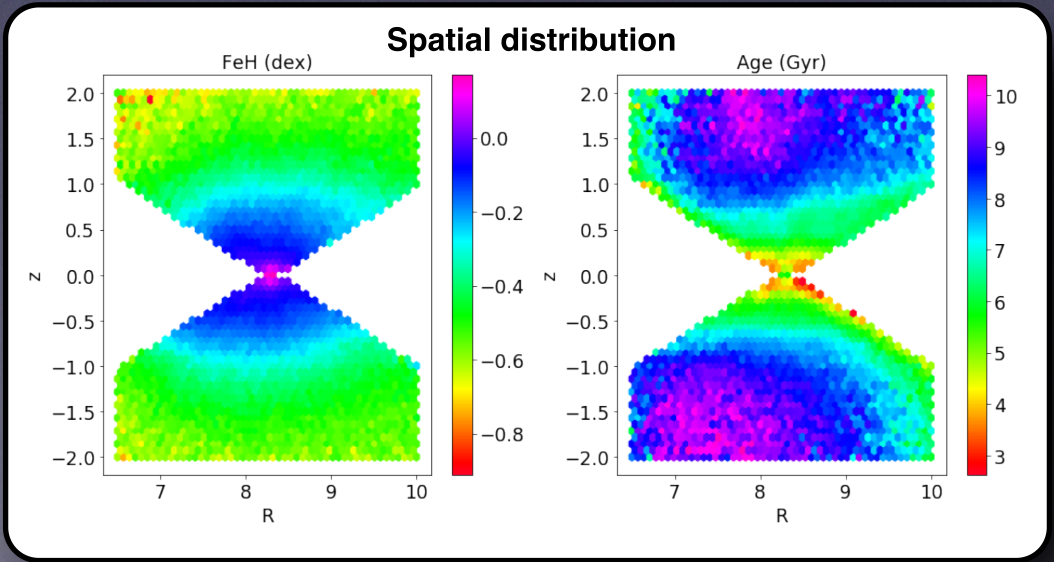


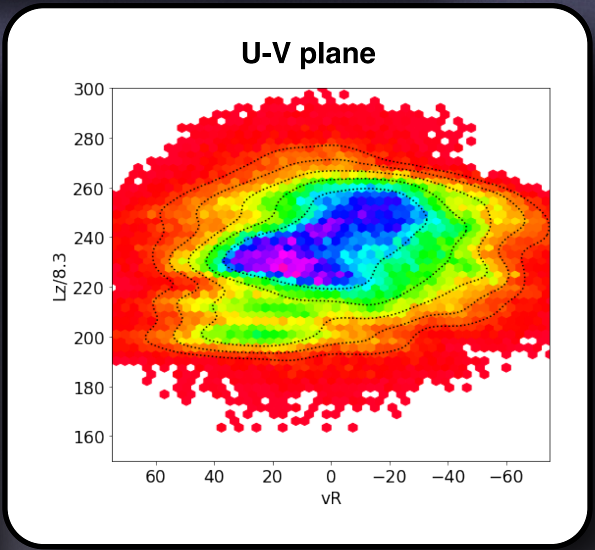
Applications

- Using all-sky GALEX data gives us around 2 million turn-off stars with good ages (SDSS gives ~6M)
- If we want 6D phase-space we can cross-match GALEX and Gaia's onboard spectrograph RVS, giving around 0.5 million stars
- Other avenues not discussed here include the phase-space snail (more prominent in younger stars) & substructures in action space









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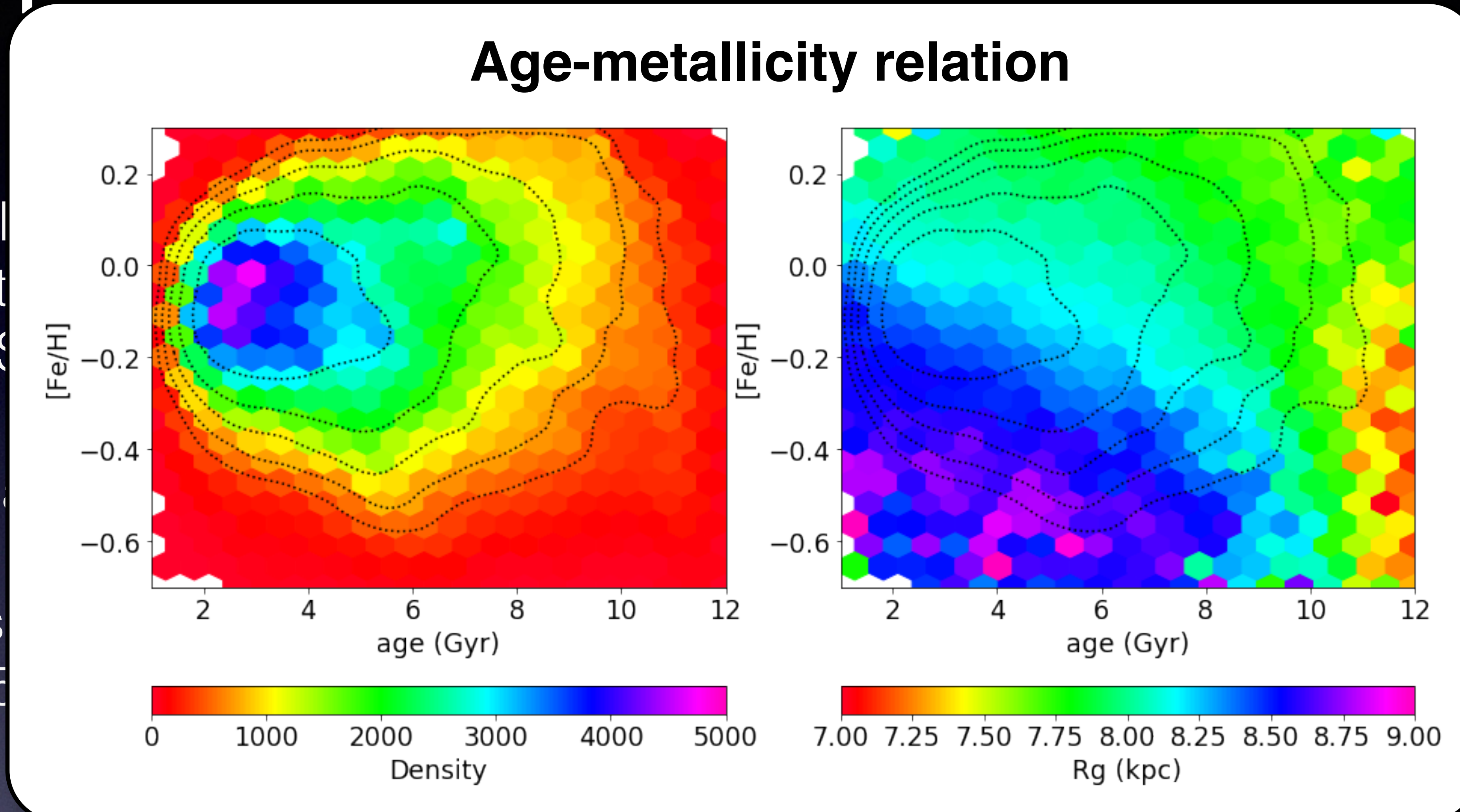
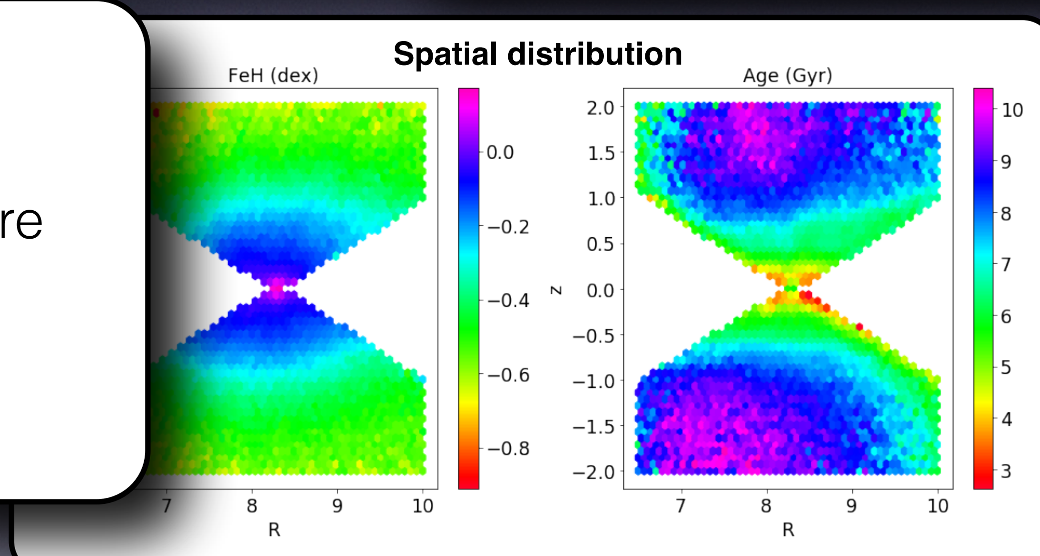
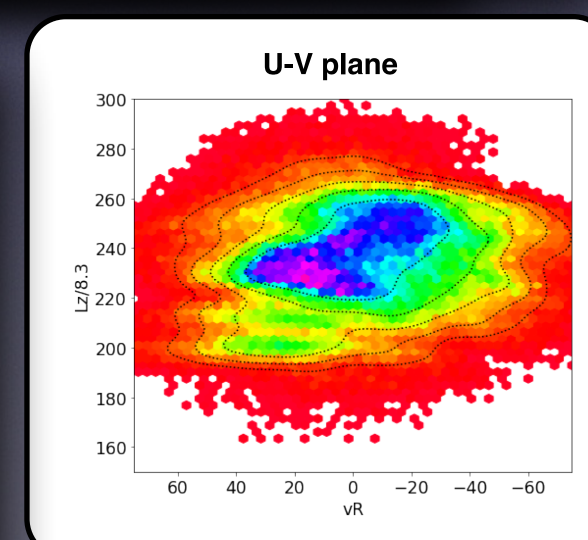


Age-Metallicity relation

- By plotting the guiding centre radii we can see the effects which work to broaden this relation.





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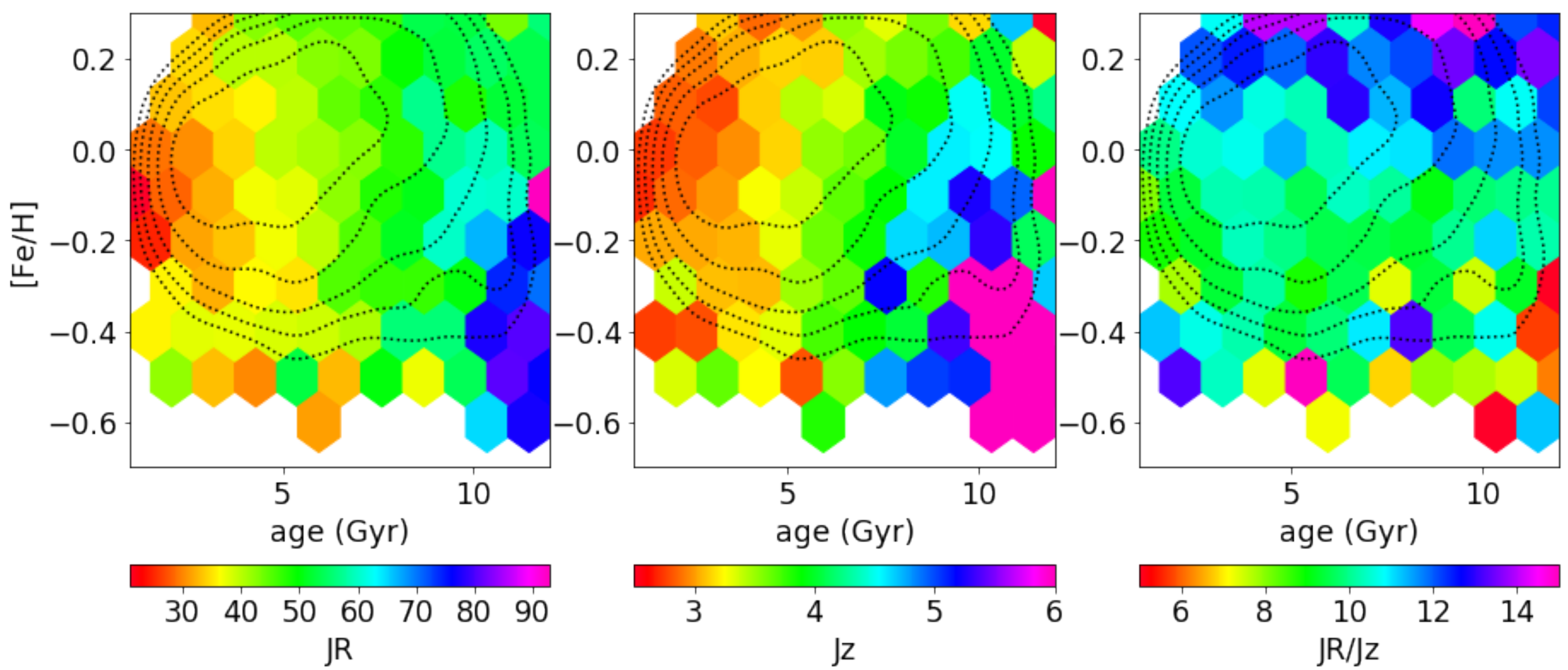
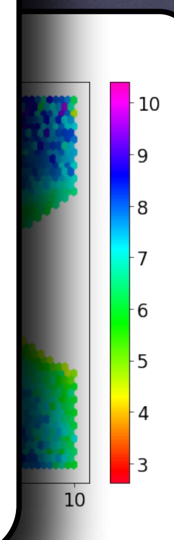
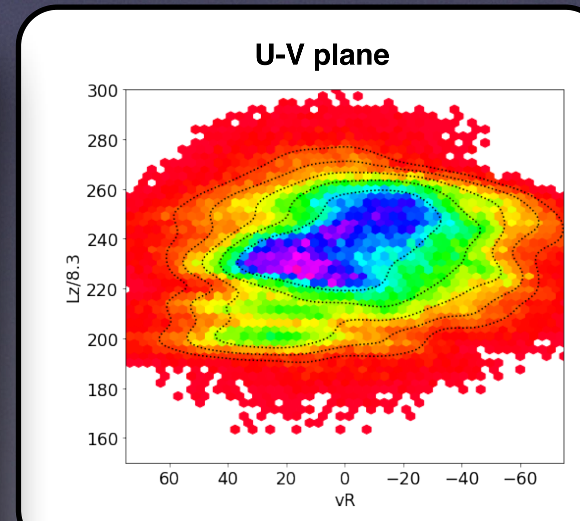


Radial migration

- Here we show the age-metallicity plane for stars with R_g = 7 kpc.
- As expected, older stars are hotter in both J_R and J_z.
- However, plotting the ratio shows that the (probable) migrated stars have high values of J_R/J_z. Is this because migration preferentially occurs for stars with proportionally smaller J_z?





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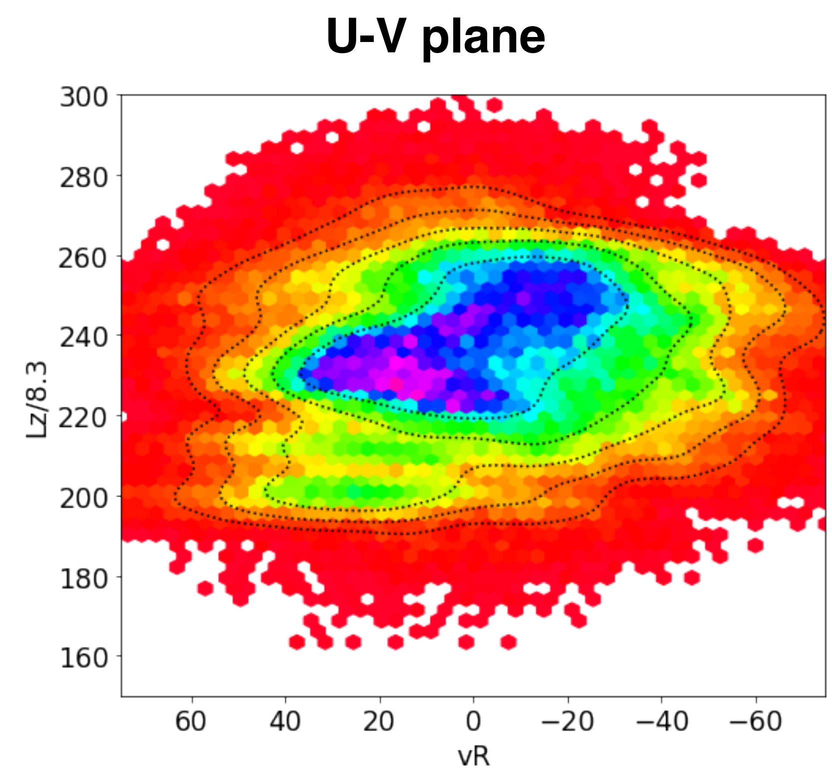
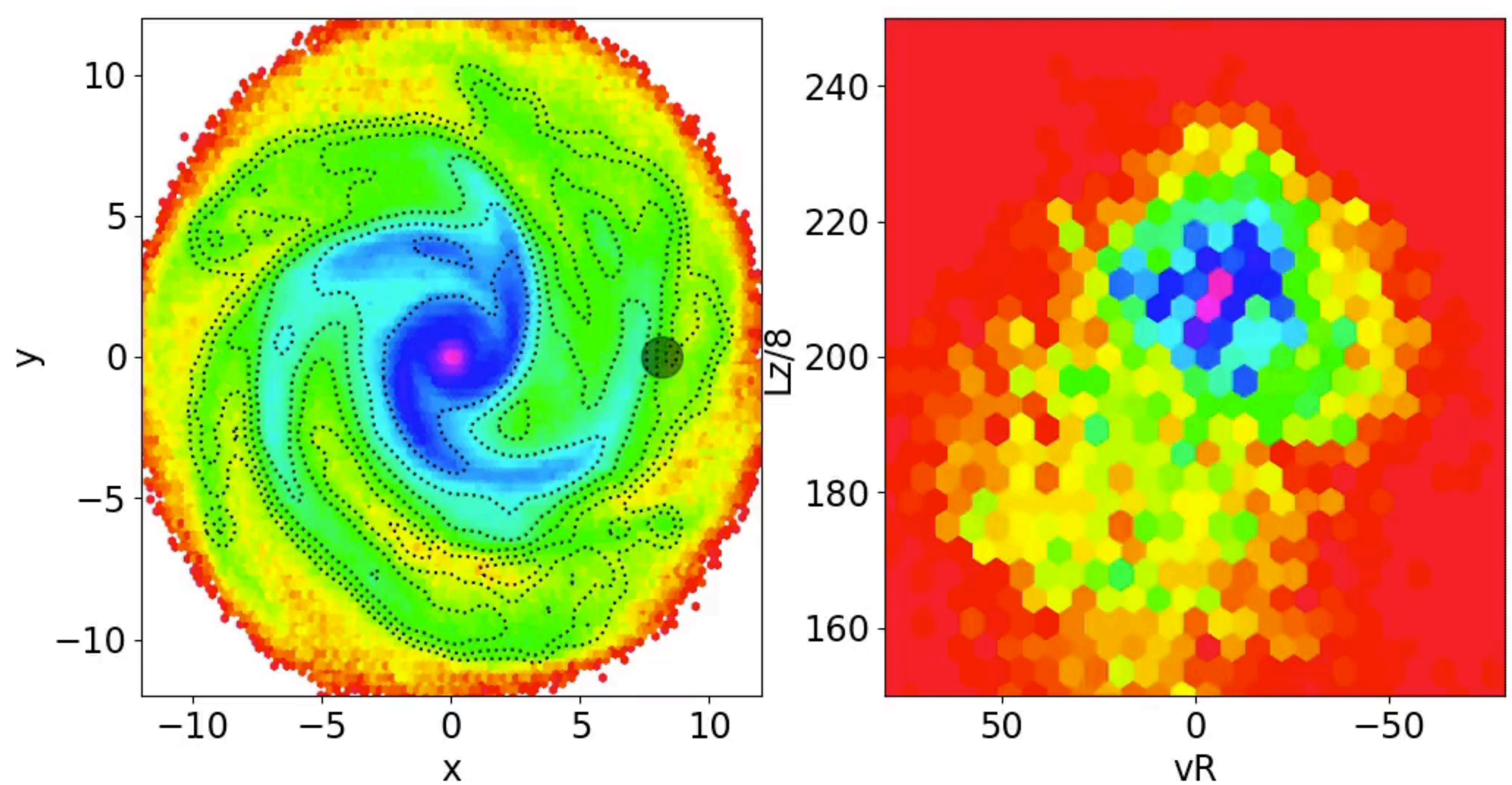


Simulation from Alex Pettitt



U-V plane

- Vertex deviation and complex substructure
- Spirals are able to match overall structure, but how much of the substructure too?
- Hercules stream seems to bifurcate, showing signature in age but not [Fe/H]

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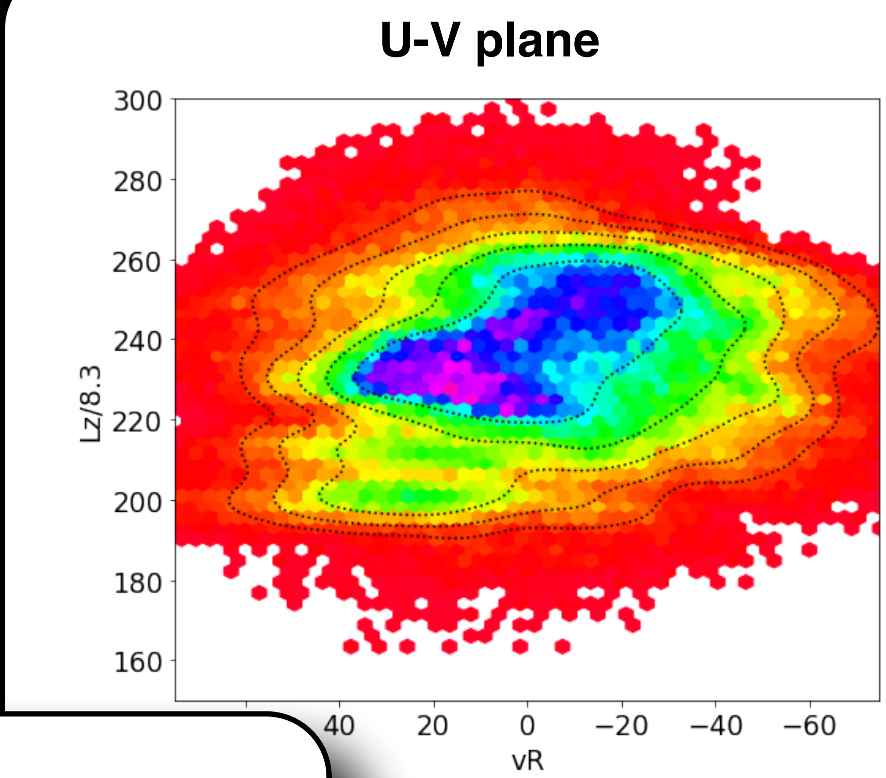
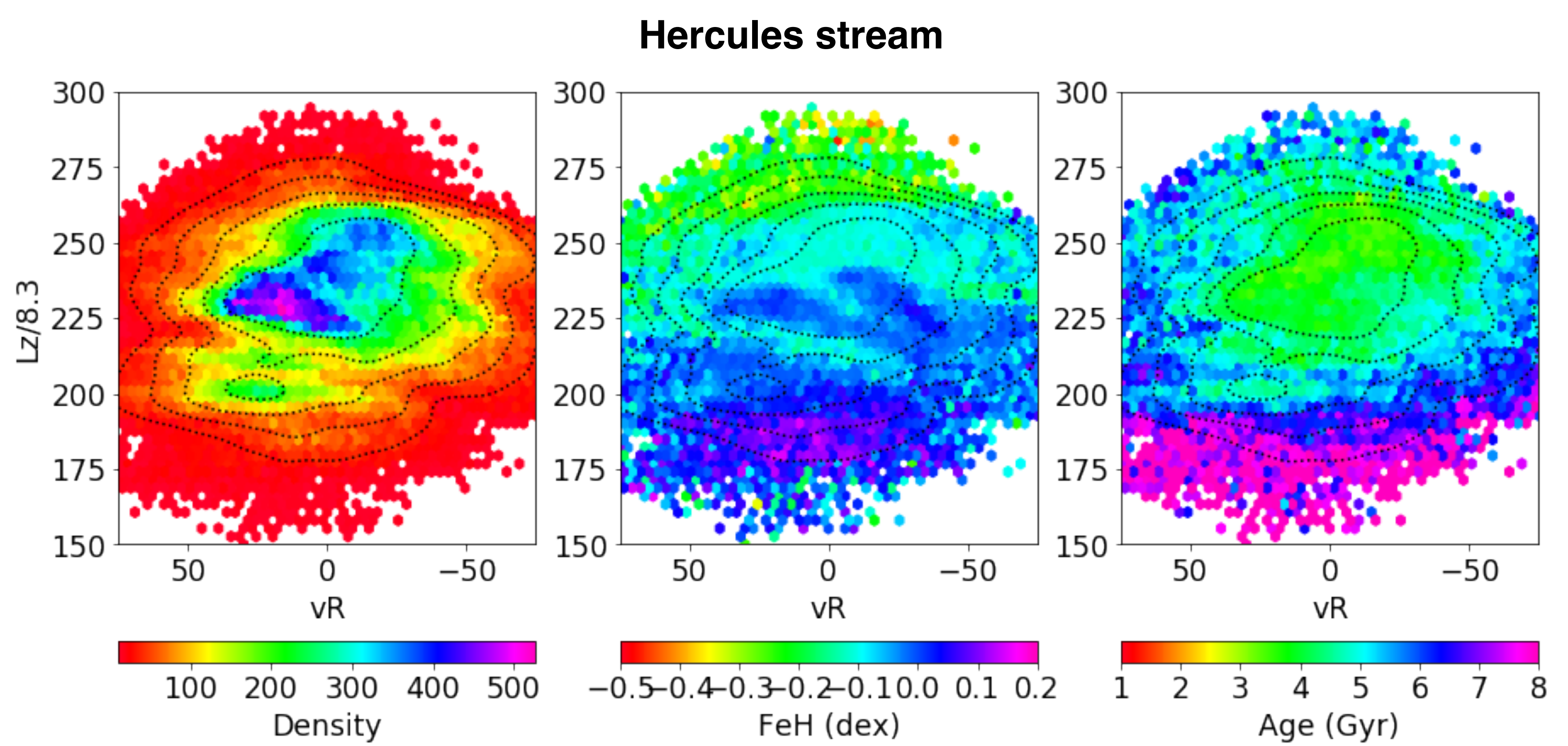
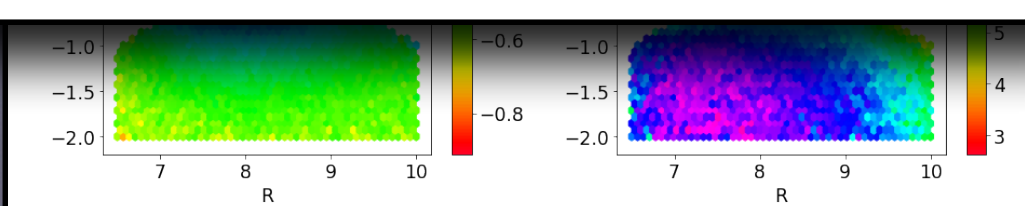




in action space



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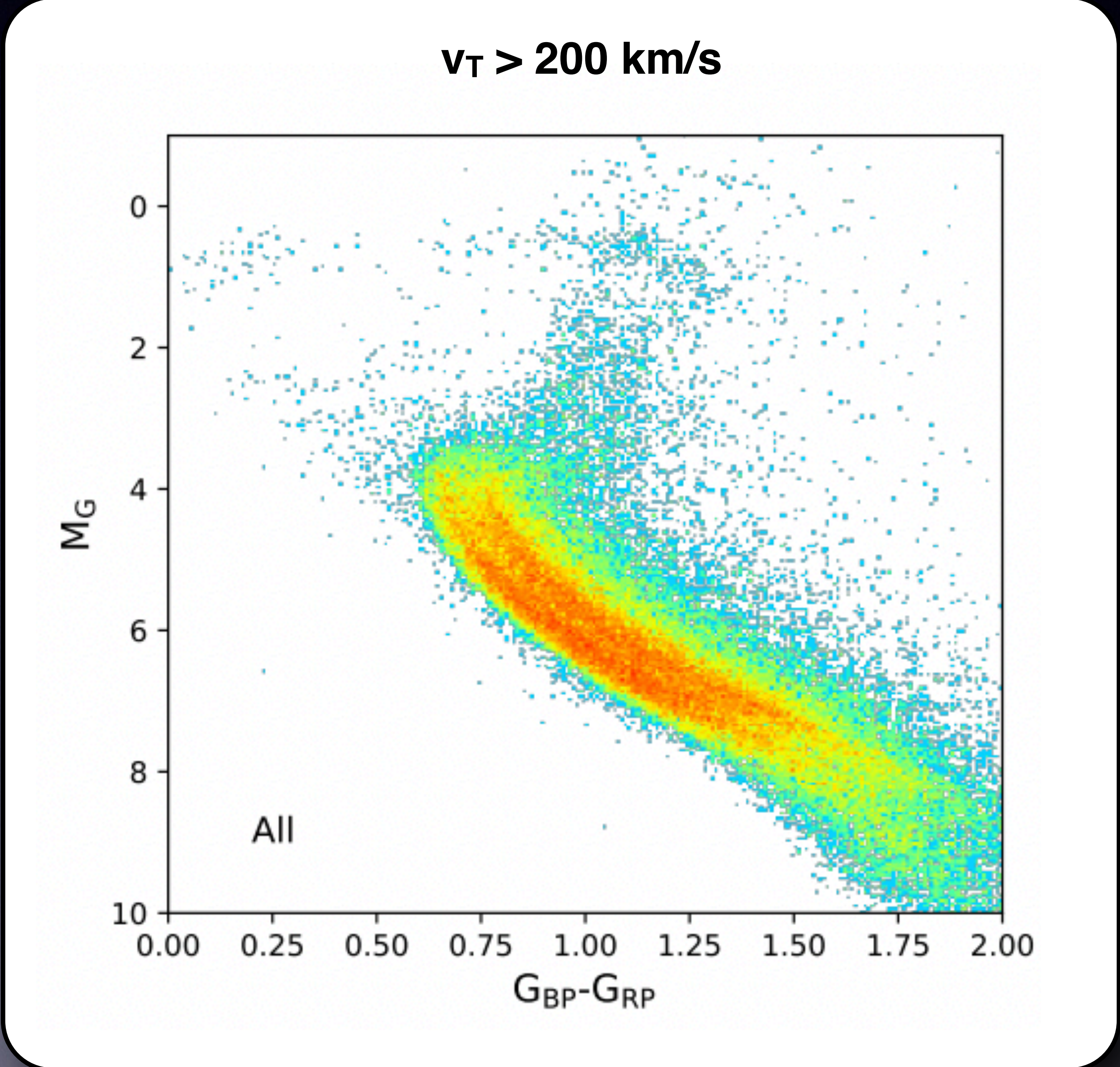
High v_T stars

- Much interest has been generated by dual “halo” track seen in the Gaia DR2 HR diagram
- If we look at our sample within 2 kpc, we see a metal-rich component similar to what we expect from the thick disc
- Turns out that you can reproduce the v_T distribution with a standard halo (~80%) + thick-disc (~20%)
- We can also see that proposed halo substructures (Haywood+ 2018) are reproduced by smooth models, i.e. are a natural consequence of orbits



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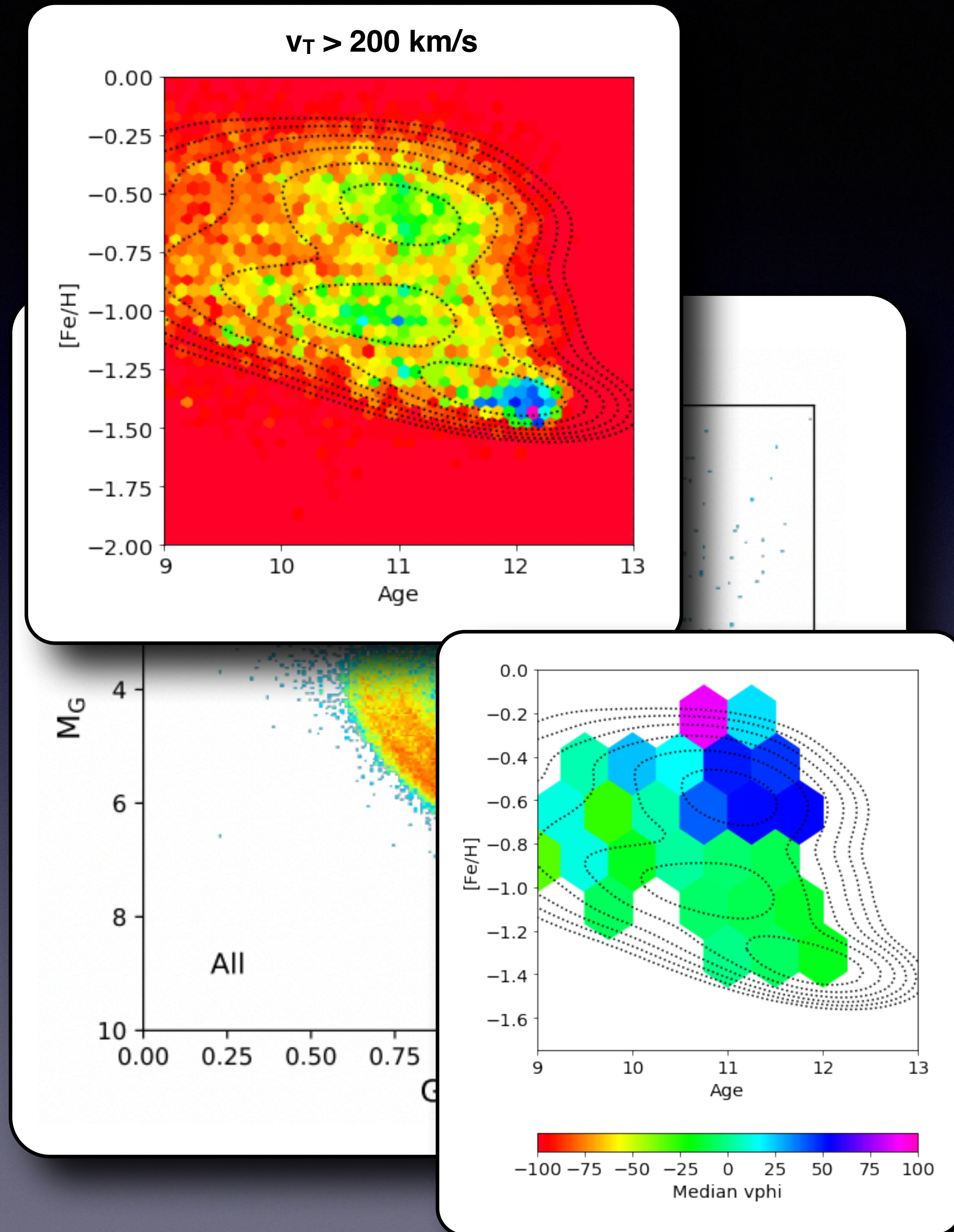

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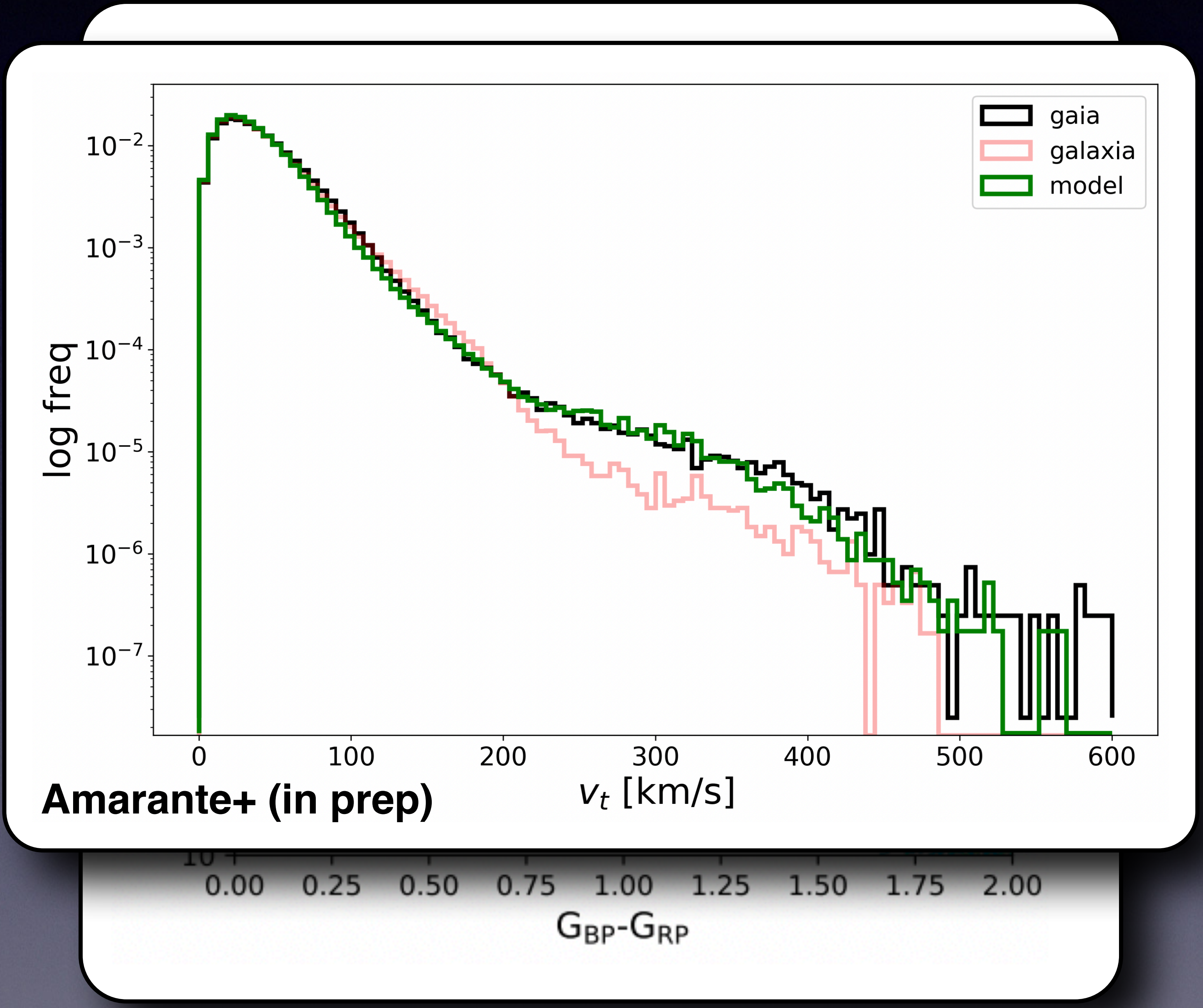

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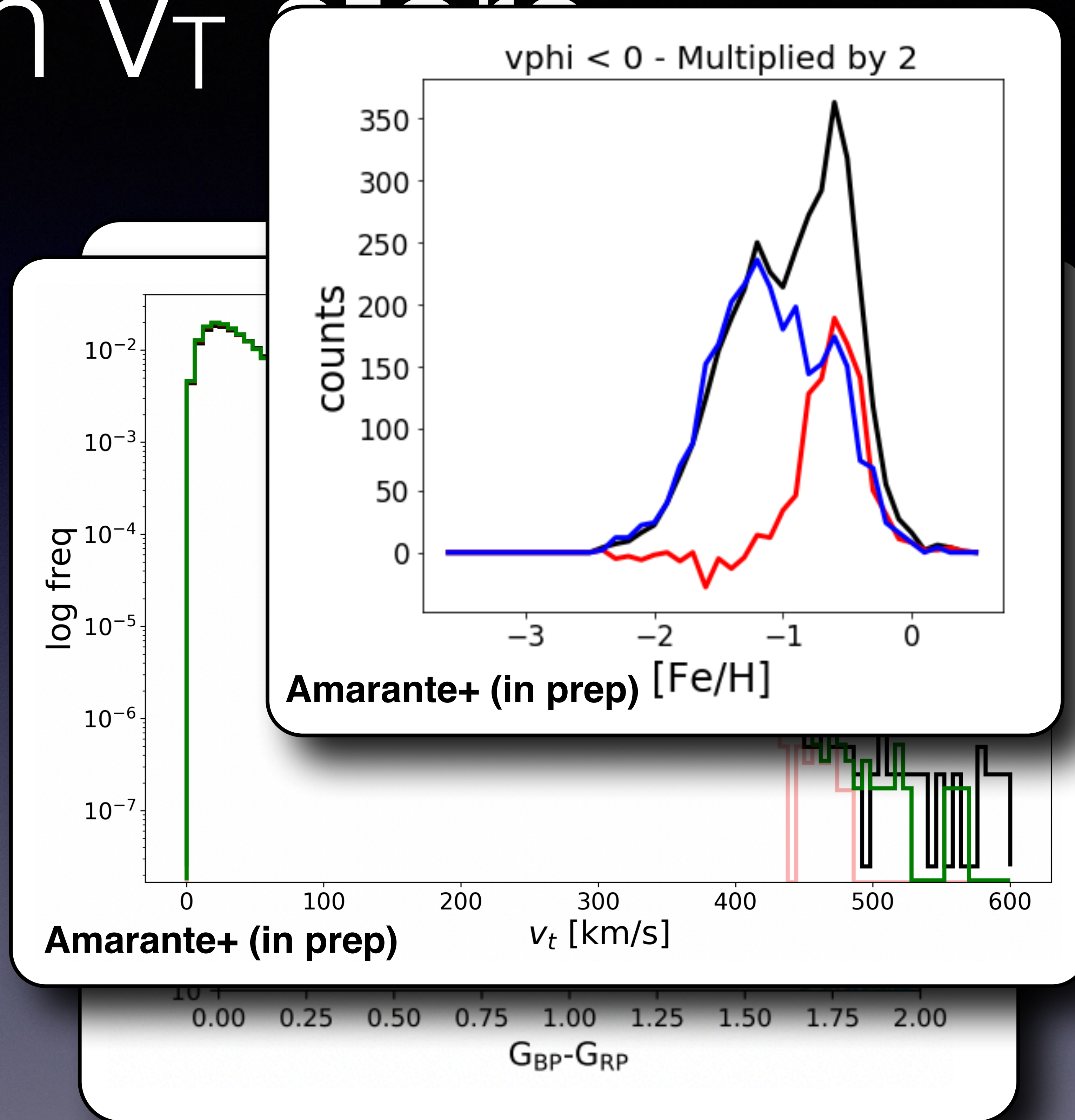

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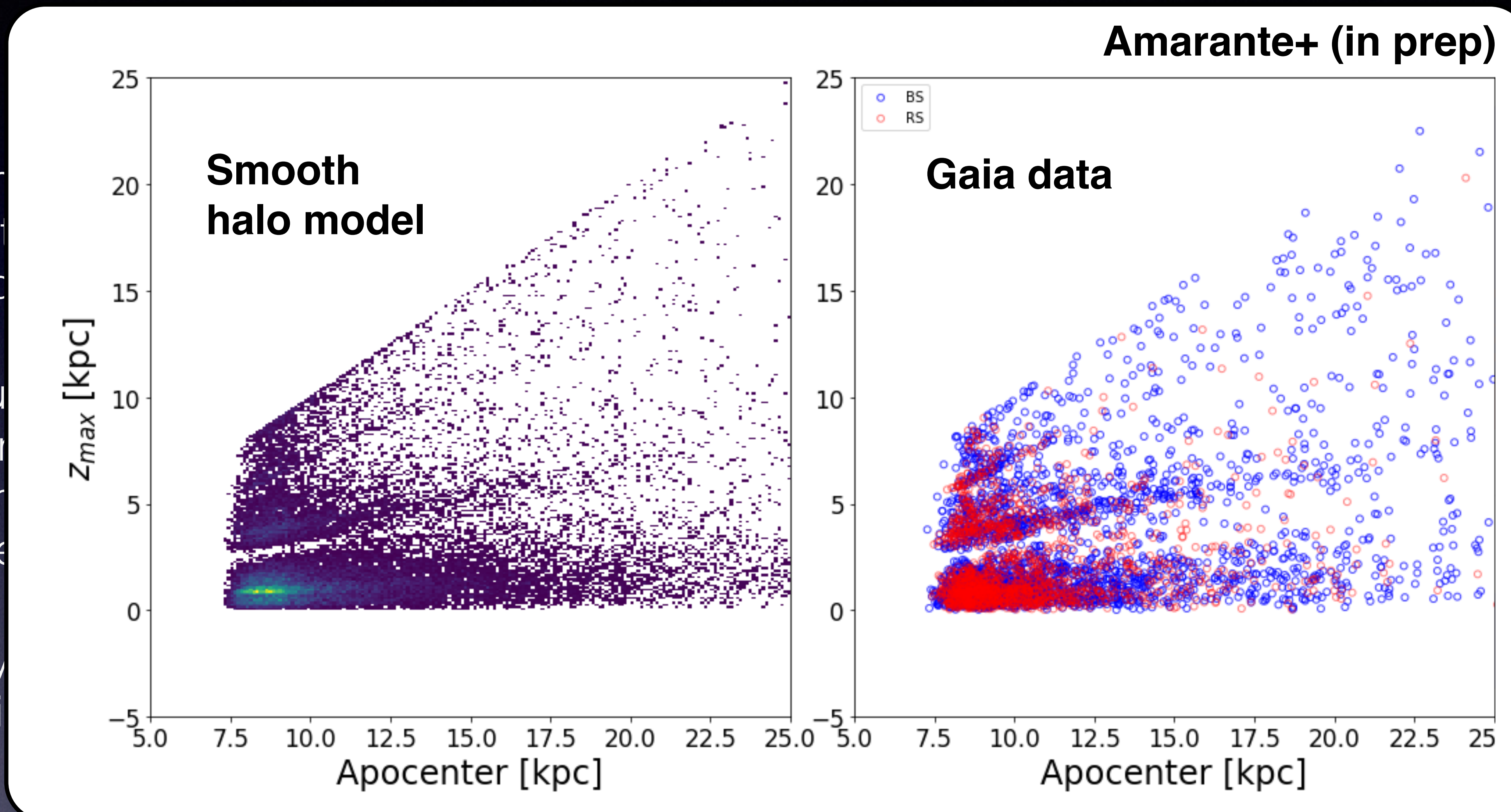

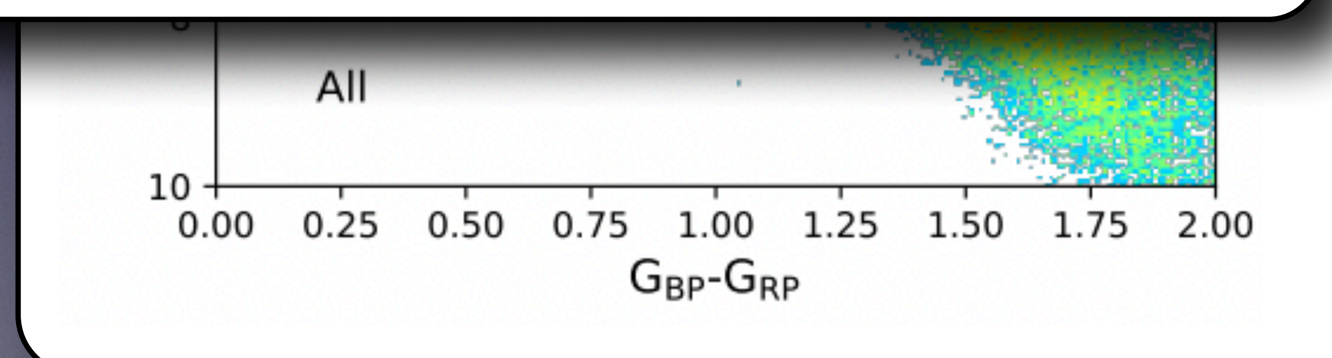

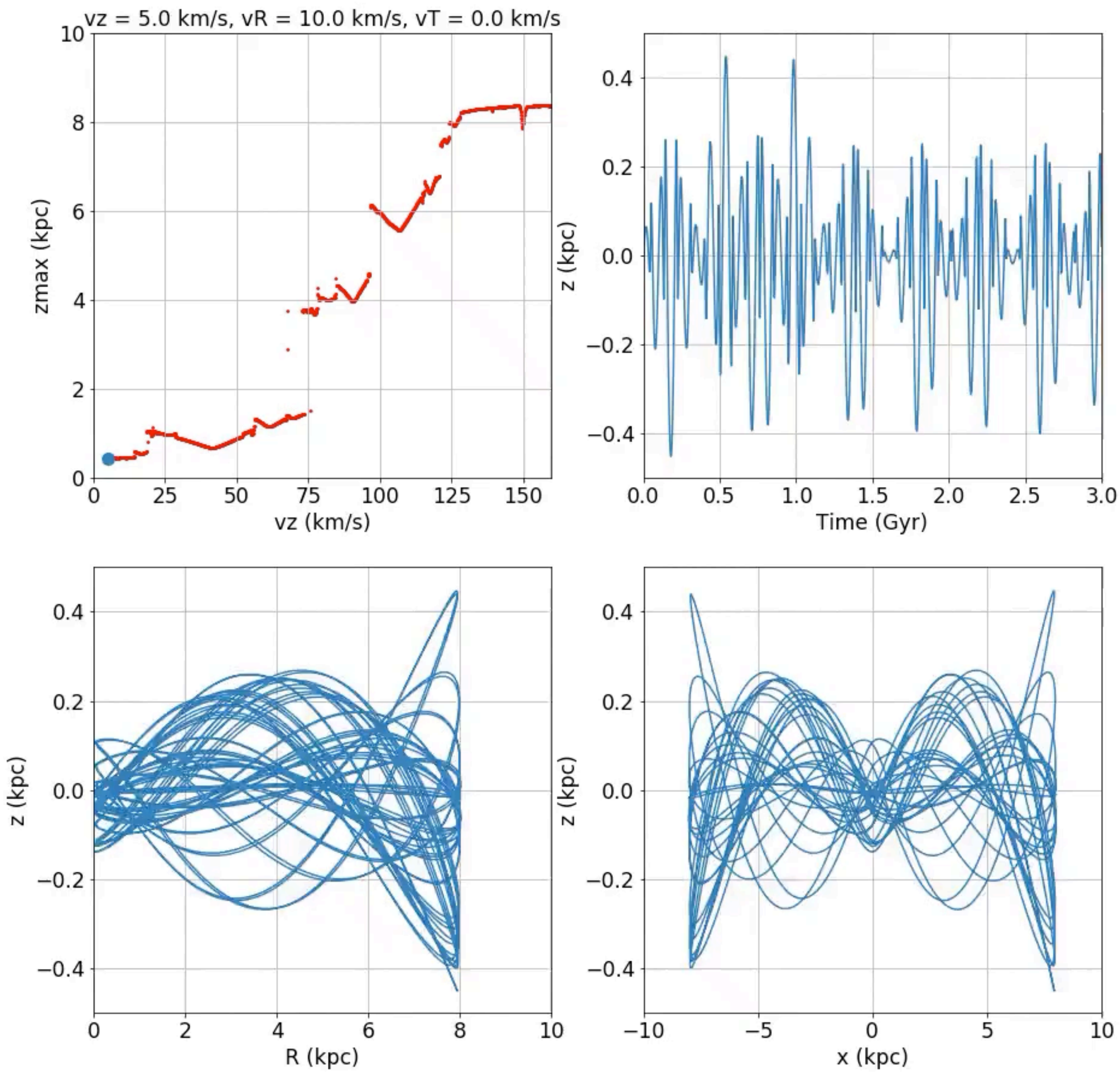
vz = 5.0 km/s, vR = 10.0 km/s, vT = 0.0 km/s
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vz (km/s)
z (kpc)
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x (kpc)

Summary

- LAMOST has a lot of good S/N spectra (~5 M), with DR5 arriving by the end of the month
- LAMOST-2 now on-going, with both low-res survey and new medium resolution component (see Chao Liu talk)
- Great synergy with Gaia, allowing us to dissect the disc and halo
- Photometric metallicities allow us to estimate ages for millions of stars, focusing on well-understood samples (e.g. turn-off/sub-giant stars)