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FAVORITES

- Exoplanets
- Metallicity
- Statistics
- Planet Occurrence Rate

GROUPS

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title

The Rich Get Richer: More Planets Around Metal-Rich Stars Except For $R_P \leq 2\ R_{Earth}$

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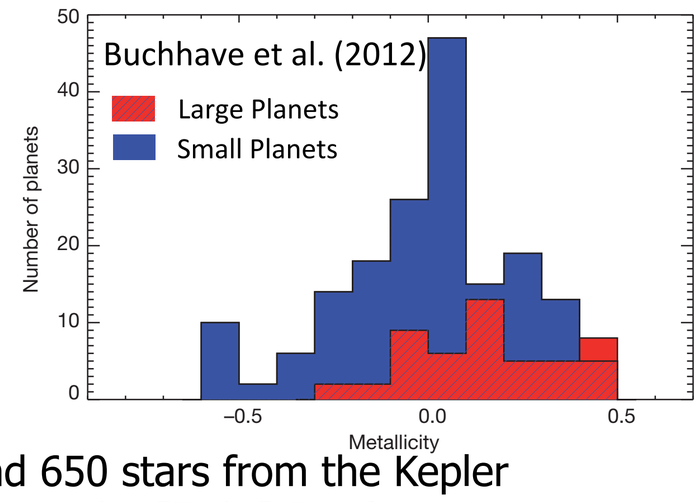
Large planets are more abundant around metal-rich stars[1,2,3], but there is a debate on whether this trend applies to small planets.



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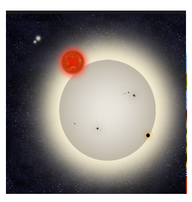
There is no metallicity dependence for small planets (R_P < 4 R_{Earth}), see the plot on the right.

Wait, let us take another look. I will study a larger sample and consider non-detections, which gives me a quantitative measure of how planet occurrence rates change with stellar metallicity.



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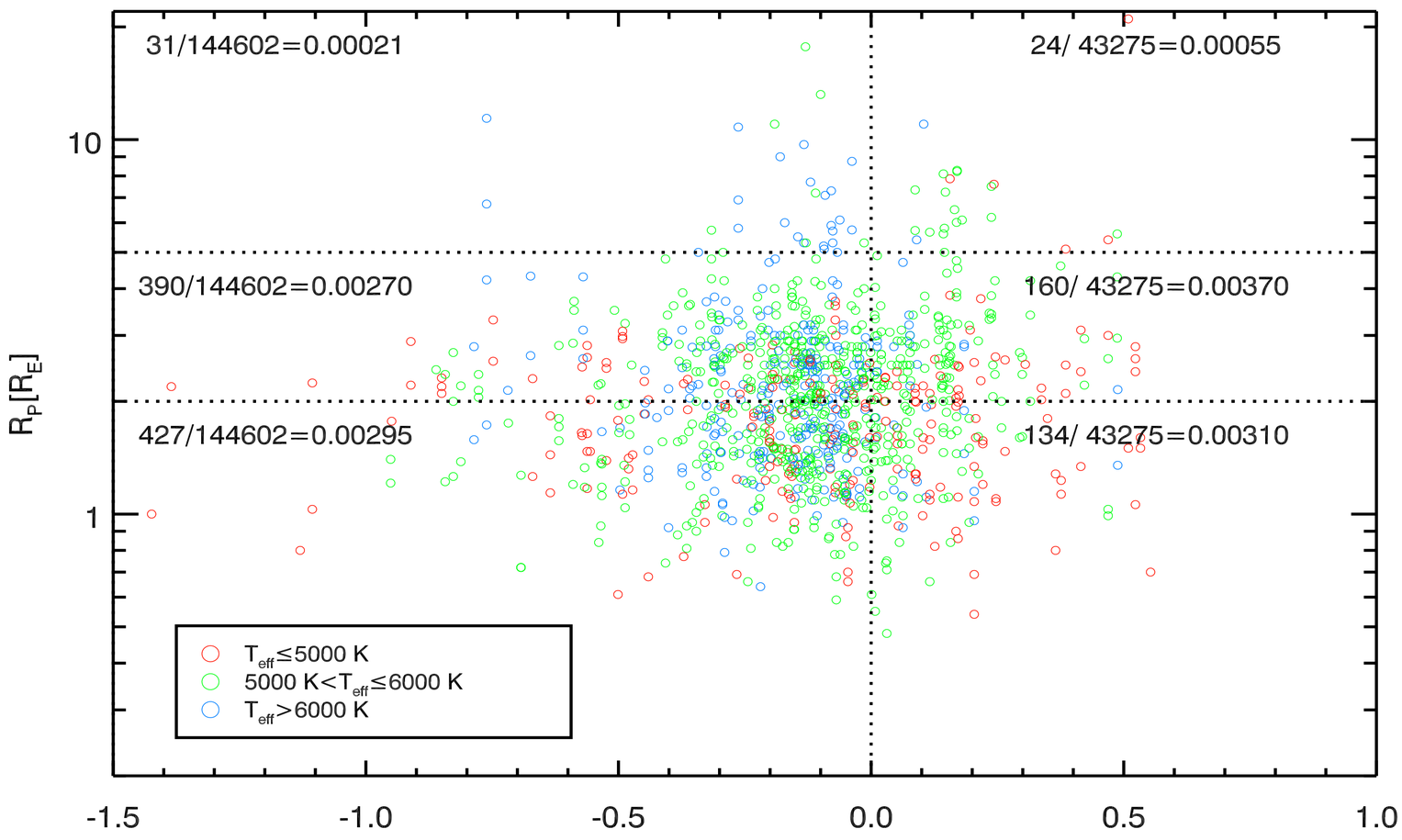
We selected 1166 multi-planet candidates around 650 stars from the Kepler mission[3,4,5] and divided them into 6 sub-regions on the [Fe/H]-R_p plane. We calculated the fraction of stars with planets in each sub-region, which gives the relative planet occurrence rate of metal-rich and metal-poor stars.



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The detection incompleteness (excluding geometric effect) is low for gas giant planets and Neptune-like planets. The incompleteness is non-negligible for small-radii planets, but we expect the incompleteness similarly affects the metal-rich and metal-poor samples. Therefore, the ratio of the fraction of stars with planets is the relative planet occurrence rate between metal-rich and metal-poor stars.

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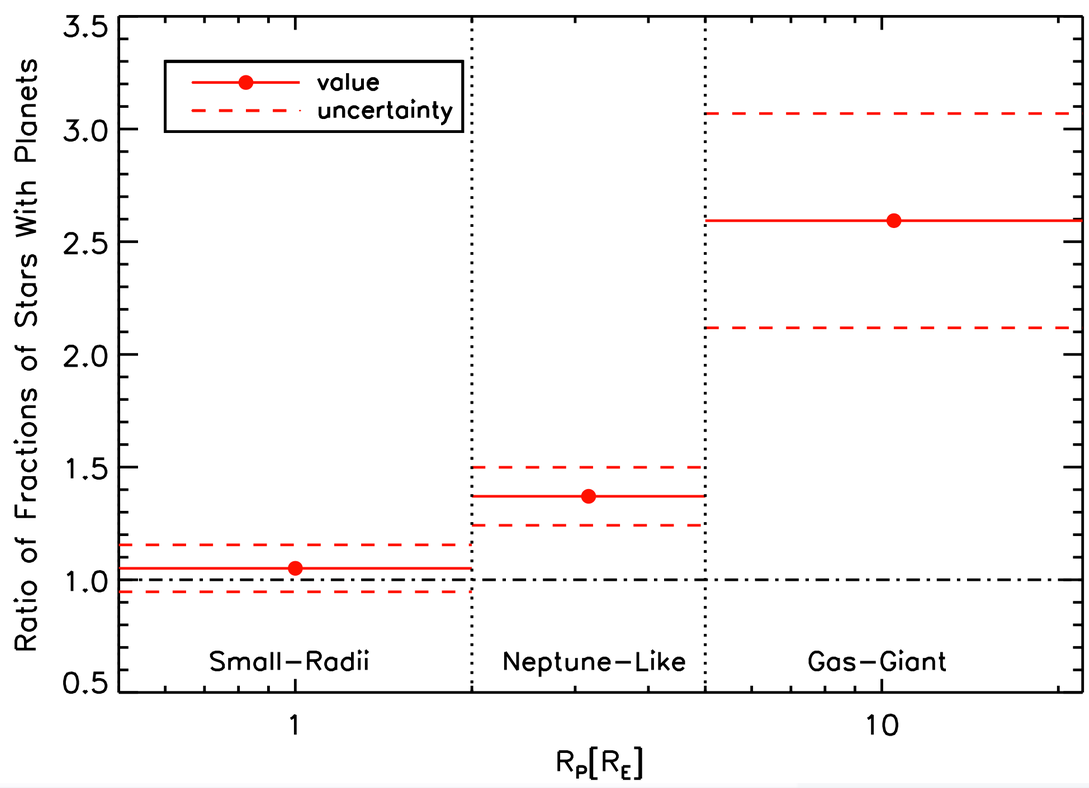
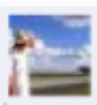
Here is the result! Gas giant planets are 2.6 times more abundant around metal-rich stars than metal-poor stars. Neptune-like planets are 1.4 times more abundant around metal-rich stars, but the planet occurrence rate for small-radii planets is not dependent on stellar metallicity.





We found a planet-metallicity correlation for Neptune-like planets which previous studies have not found. One possible explanation is: previous studies considered small planets with R_P < 4 $R_{Earth,}$ which results in a mixture of Neptune-like planets and small-radii planets. A dilution/cancelling effect would be induced if the Neptune-like planet occurrence rate is metallicity-dependent and the small-radii planet occurrence rate is not.

Small-radii planets may be more abundant around metal-poor stars, i.e., there may be a negative planet-metallicity correlation for small-radii planets. Small-radii planets are more difficult to find around metal-poor stars because these stars are in general more distant, brighter and larger. The higher incompleteness for small-radii planets around metal-poor stars than metal-rich stars may suggest that small-radii planets are intrinsically more abundant around metal-poor stars.

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ACKNOWLEDGEMENT

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