High-contrast Imaging of Intermediate-mass Giants with Long-term Radial Velocity Trends

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The radial velocity (RV) technique has been used as one of the methods to search for exoplanets, discovering more than 500 planets in last 20 years. However, this technique is less sensitive to wide-orbit (> 10 au) planets and inefficient to examine the occurrence rate of such wide-orbit planets, even though it is crucial information to test planet formation/evolution theories.

A long-term RV acceleration (RV trend) suggests the presence of a possible planetary companion in a wide orbit. However, such an RV trend could be caused not only by a planet but also by a distant stellar or brown dwarf companion. Direct-imaging technique is sensitive to such wide-orbit companions and can help us to clarify the cause of an RV trend through a detection or non-detection of companion.

Our RV survey conducted at Okayama Astrophysical Observatory (OAO) has targeted intermediate-mass giants (1.5–5 \(M_\odot\)) for over a decade [1], finding the long-term RV trends around several targets. To clarify the nature of the RV trends observed in the OAO and another different RV survey [2], we performed direct-imaging observations for the six OAO targets as part of the SEEDS project [3]. (\(\gamma\) Hya, \(i\) Dra, 18 Del, HD 5608, HD 14067, HD 109272).

We detected three stellar companions (0.61\(^{+0.01} \)\(^{-0.01} \) \(M_\odot\), 0.10 \(\pm\) 0.01 \(M_\odot\), 0.28 \(\pm\) 0.06 \(M_\odot\)) in three systems (\(\gamma\) Hya, HD 5608, and HD 109272) and rule out the presence of stellar companions in the other three systems (\(i\) Dra, 18 Del, HD 14067).

Combining the direct imaging and the RV data, we found that the detected companions are responsible for the observed RV trends and the causes of RV trends for non-detection systems are low-mass stars or brown dwarfs.

![Figure 1: The detected companions are indicated by the yellow circles. The central white areas around central the stars were removed in analysis.](image)

References