

Discriminating Planetary Migration Mechanisms by the SEEDS Project

NARITA, Norio¹, KUDO, Tomoyuki¹, BERGFORS, Carolina², NAGASAWA, Makiko³
THALMANN, Christian², SATO, Bun'ei³, SUZUKI, Ryuji¹, KANDORI, Ryo¹, JANSON, Markus⁴
GOTO, Miwa², BRANDNER, Wolfgang², IDA, Shigeru³, ABE, Lyu⁵, CARSON, Joseph^{2/6}
EGNER, Sebastian, E.¹, FELDT, Markus², GOLOTA, Taras¹, GUYON, Olivier^{1/7}, HASHIMOTO, Jun¹
HAYANO, Yutaka¹, HAYASHI, Masahiko¹, HAYASHI, Saeko¹, HENNING, Thomas², HODAPP, Klaus, W.⁸
ISHII, Miki¹, KNAPP, Gillian, R.⁹, KUSAKABE, Nobuhiko¹, KUZUHARA, Masayuki^{1/10}, MATSUO, Taro¹¹
McELWAIN, Michael, W.⁹, MIYAMA, Shoken¹, MORINO Jun-Ichi¹, MORO-MARTIN, Amaya²
NISHIMURA, Tetsuro¹, TAE-SOO, Pyo¹, SERABYN, Eugene¹¹, SUENAGA, Takuya^{1/12}, SUTO, Hiroshi¹
TAKAHASHI, Yasuhiro, H.^{1/12}, TAKAMI, Michihiro¹³, TAKATO, Naruhisa¹, TERADA, Hiroshi¹
TOMONO, Daigo¹, TURNER, Edwin, L.^{9/10}, WATANABE, Makoto¹⁴, YAMADA, Toru¹⁵
TAKAMI, Hideki¹, USUDA, Tomonori¹, TAMURA, Motohide¹

1: NAOJ, 2: Max Planck Institute for Astronomy, 3: Tokyo Institute of Technology, 4: University of Toronto, 5: Universite de Nice Sophia-Antipolis, 6: College of Charleston, 7: University of Arizona, 8: University of Hawaii, 9: Princeton University, 10: University of Tokyo, 11: Jet Propulsion Laboratory, California Institute of Technology, 12: Graduate University for Advanced Studies, 13: Academia Sinica, 14: Hokkaido University, 15: Tohoku University

Planetary orbits reflect their migration history. It is now known that there are many exoplanets with eccentric and/or highly tilted orbits. Those exoplanets are considered to have migrated through planet-planet scattering or the Kozai migration. It is difficult, however, to discriminate these two migration mechanisms, since both mechanisms predict eccentric and/or highly tilted orbits. To discriminate the two migration mechanisms, it is necessary to search for counterparts of their migration (e.g., giant planets for planet-planet scattering or a distant companion for the Kozai migration). We thus started high-contrast direct imaging observations for eccentric or tilted planetary systems in the SEEDS (Strategic Explorations of Exoplanets and Disks with Subaru) project.

We first observed a retrograde planetary system HAT-P-7, for which the Subaru telescope found the retrograde orbit of HAT-P-7b in 2009[1], with the HiCIAO (High Contrast Instrument for the Subaru Next Generation Adaptive Optics) onboard the Subaru. We found that there are two companion candidates around the HAT-P-7 system (see Figure 1)[2]. Although it is not yet known whether those candidates are physically associated with HAT-P-7 or not, if associated, those companions are M stars and separated by at least 1000 AU. We then calculated whether those companion candidates can cause the Kozai migration for the inner retrograde planet. We found that it is impossible for the companion candidates to cause the Kozai migration in the presence of an outer planet around the retrograde planet (reported by [3]). As a result, we conclude that it is the most plausible that the retrograde planet HAT-P-7b has migrated through planet-planet scattering. The SEEDS project will conduct this kind of observations for dozens of planetary systems to discriminate planetary migration mechanisms.

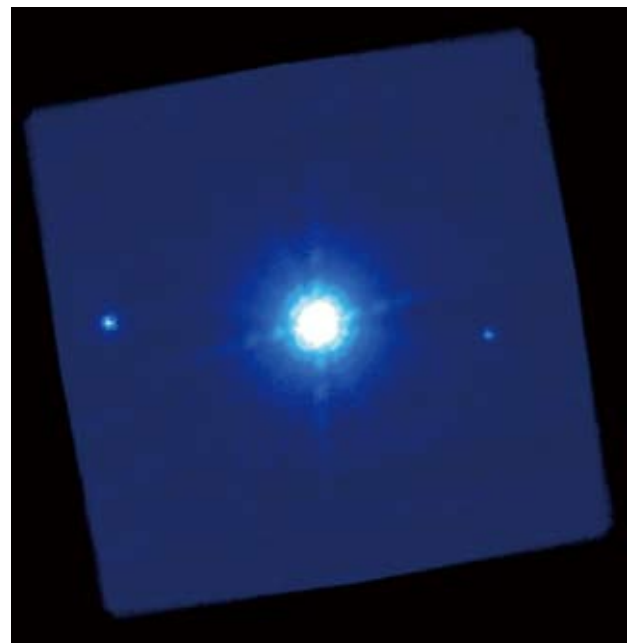


Figure 1: An image of HAT-P-7 taken with the Subaru HiCIAO. Two companion candidates are detected around HAT-P-7. The field of view is 12" × 12". North is up and east is to the left.

References

- [1] Narita, N., et al.: 2009, *PASJ*, **61**, L35-L40.
- [2] Narita, N., et al.: 2010, *PASJ*, **62**, 779-786.
- [3] Winn, J. N., et al.: 2009, *ApJ*, **703**, L99-L103.