

The SOPHIE search for northern extrasolar planets-XIX. HD88986: a multi-planet system with a temperate transiting sub-Neptune and a wide-orbit Jupiter mass planet

Transiting planets with orbital periods longer than 40 days are extremely rare among the 5000+ discovered planets. Consequently, the lack of these populations poses a challenge to research into planetary demographics, formation, and evolution, as well as the star-planet relationship. In this talk, we propose the discovery and characterization of HD88986 b, a transiting sub-Neptune planet with one of the longest orbital periods, and its Jupiter-like companion. To validate this discovery, we used a combination of more than 25 years of extensive radial velocity measurements (440 SOPHIE data, 31 ELODIE data, 34 HIRES data), Gaia DR3 data, 21-year photometric observation of an automatic photoelectric telescope (APT), 2 sectors of TESS data, and a 7-day observation of CHEOPS. Our analysis shows that the sub-Neptune planet has a radius of $2.360_{-0.099}^{+0.10} R_E$ and a mass of $19.4_{-2.6}^{+2.7} M_E$, and it orbits every $146.4_{-0.05}^{+0.05}$ days around one of the nearest and brightest stars, HD88986 (G2V type, $G_{mag}=6.30$, distance= 30 pc). The second planet, using Gaia DR3 excess noise, is compatible with an edge-on configuration, and the probability that HD88986 c is a planet with a mass smaller than $13.5 M_{jup}$ is $\sim 94\%$. The discovery of HD88986 b and its Jupiter-like companion, whose configuration has some similarities with that of our own solar system, will have a significant impact on our understanding of the puzzle of planetary formation and evolution, as well as planetary habitability. **The temperate nature of HD88986 b** ($T_{eff}= 476_{-10}^{+13}$), thanks to its long orbital period, will open up exciting opportunities for future studies of internal structure and atmosphere characterization.