The Direct Imaging Research of Exoplanets with Ground-based Telescopes and Space Missions

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With over 3000 exoplanets have been discovered mostly by indirect detection approaches, none Earth-twin planet has been 100% confirmed. The high-contrast imaging technique can directly detect the photons from the planet itself, thus open the window for spectroscopy research, which will finally allow the confirmation of the terrestrial life signals by precisely analysis the atmosphere of an Earth-like planet in the habitable zone of a solar type star. Thus the direct imaging technique will be crucial to answer one of the most fundamental scientific questions of "Are we alone in the universe?".

In this talk, I will present our recent high-contrast imaging technique and observations on middle sized telescopes, which includes the ESO's 3.6-meter NTT, 3.5-meter ARC telescope in the Apache Point Observatory as well as the 2.7-meter HJS telescope in McDonald Observatory. The system is composed of a very compact extreme adaptive optics, stellar coronagraph and the post-processing image technique. As an initial result, it can reach a contrast level of 10^{-6}, which is among one of the best performances of planet imaging programs such as Gemini/GPI and VLT/SPHERE. Its unique feature can activate the high-contrast imaging power for current middle/small telescopes. With more observation time available, our research will be a very important compensation to these programs on 8-meter telescopes.

Meanwhile, I will briefly present the exoplanet imaging program on our proposed 12-meter optics telescope, which has been listed the top of the "13^{th} five-year plan". And the conceptual design will be discussed. Finally, I will talk about the Cool Planet Imager (CPI, including two ambitious missions of JEEEDIS and EELS), a going-on program on the research of Earth-like exoplanets and terrestrial life-signals in future space missions, which has listed the top among programs in the Strategic Priority Research Program of CAS, Space Astronomy of Year of 2016-2030.