SEARCHING FOR PLANETS WITH VLBI

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Astrometric VLBI observations of radio stars are being made to connect the Hipparcos star catalog to the extragalactic radio reference frame. A phase-referencing technique has been developed to allow reliable detection of fringes from the (relatively weak) radio stars. In this technique, the radio antennas are moved between a star and a strong, compact reference source a few degrees away every 2-3 minutes. After correlation, the strong reference source fringes are used to determine the exact delay and rate of the weak radio star fringes, allowing the fringe amplitude and phase to be measured and coherently integrated over periods far longer than the usual coherence time of VLBI observations (up to the total duration of the experiment). As a result, accurate astrometry has been possible on radio stars with flux densities as low as 2 mJy. All five astrometric parameters (two positions, two proper motions, and one parallax) have been obtained for several stars, with formal errors and epoch-to-epoch residuals less than one milliarcsecond. Our best result to date is for the star σ^2CrB, where the post-fit position residuals over 12 epochs have an rms scatter of only 0.2 milliarcsecond. This is very close to the precision needed to detect a Jupiter mass planet in this system. A continuing effort to understand and reduce unmodeled systematic errors is expected to reduce the scatter in the post-fit residuals to nearly the thermal noise limit of 20 microarcseconds. At this level of precision, phase-referenced VLBI will be able to detect Jupiter-like planets orbiting any of five nearby radio stars at a confidence level of 4-10 sigma. Based on the example provided by our solar system, the existence of a Jupiter-like planet is indicative of a more complex planetary system that could include terrestrial planets. Further improvements in sensitivity planned for the next few years will allow a much larger sample of stars to be regularly observed with VLBI.