

# Transits of Venus: From Earth, Jupiter, and Saturn

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## Abstract

We observed the 2012 June 6/5 transit seen from Earth (E/ToV), simultaneously with Venus Express and several other spacecraft not only to study the Cytherean atmosphere but also to provide an exoplanet-transit analog. From Haleakala, the whole transit was visible in coronal skies; among our instruments was one of the world-wide Venus Twilight Experiment's nine coronagraphs. Venus's atmosphere became visible before first contact. SacPeak/IBIS provided high-resolution images at H $\alpha$ /carbon-dioxide. Big Bear's NST also provided high-resolution observations of the Cytherean atmosphere and black-drop evolution. Our liaison with UH's Mees Solar Observatory scientists provided magneto-optical imaging at calcium and potassium. Solar Dynamics Observatory's AIA and HMI, and the Solar Optical Telescope (SOT) and X-ray Telescope (XRT) on Hinode, and total-solar-irradiance measurements with ACRIMSAT and SORCE/TIM, were used to observe the event as an exoplanet-transit analog. On September 20, we imaged Jupiter for 14 Hubble Space Telescope orbits, centered on a 10-hour ToV visible from Jupiter (J/ToV), as an exoplanet-transit analog in our own solar system, using Jupiter as an integrating sphere. Imaging was good, although much work remains to determine if we can detect the expected 0.01% solar irradiance decrease at Jupiter and the even slighter differential effect between our

violet and near-infrared filters caused by Venus's atmosphere. We also give a first report on our currently planned December 21 Cassini UVIS observations of a transit of Venus from Saturn (S/ToV). Our E/ToV expedition was sponsored by the Committee for Research and Exploration/National Geographic Society; supplemented: NASA/AAS's Small Research Grant Program. We thank Rob Ratkowski, Stan Truitt, Rob Lucas, Aram Friedman, and Eric Pilger '82 at Haleakala, and Joseph Gangestad '06 at Big Bear for assistance, and Lockheed Martin Solar and Astrophysics Lab and Hinode science and operations teams for support for coordinated observations with NASA satellites. Our J/ToV observations were based on observations made with HST, operated by AURA, Inc., under NASA contract NAS 5-26555; these observations are associated with program #13067.

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