

## Two high-quality types of earth-based astrometric data

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In developing ephemerides E5 for the Galilean satellites for use by the Galileo mission encounter with Jupiter in December of last year, two powerful earth-based optical data types were employed along with optical navigation frames from the Voyager mission in 1979, with mutual eclipses and occultations from four seasons in the interval 1973-1991, and Jovian eclipse timings spanning 3.3 centuries. These two data types are the photographic observations by Pasco and the CCD observations by Monet.

The two earth-based series of optical observations both have their origin with the astrometry research effort of the US Naval Observatory. One series, made by Pasco from 1967 to 1993, consists of 8462 inter-satellite photographic measurements of right ascension and declination which are on the order of 0.10 arcsec per exposure over the entire time span. There are approximately 4 exposures on each photographic plate which can be used to produce a normal point. The Pasco data from 1967 through 1975 are typically 0.13 arcsec per exposure while those from 1976 to 1993 are 0.09 per exposure, resulting in normal points on the order of 0.065 arcsec (200 km) for 1967-1975, and 0.045 (110 km) for 1976-1993. Additionally, the Pasco photographic observations are available for numerous other satellites and they are extensively employed in ephemeris development.

The second very useful data type comes from a program at the U.S. Naval Observatory Flagstaff Station led by the Monet and consists of CCD images of the Galilean satellites made on the 61-inch telescope. Each batch of CCD data (consisting of typically 30-40 exposures) yields one-sigma residuals on the order of 0.03 arcsec, or about 90 km for the 870 normal points that were employed.

The Pasco data extend for a period of 24 years while the Flagstaff data cover 4 years. Both series of astrometric data are very useful for developing ephemerides of the Galilean satellites. It is hoped that both series of observations will continue to be made so that we can learn more about the astrometric differences of the data types by comparing these two kinds of high-quality optical observations.

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