OBSERVATIONS OF THE PLANETARY SATELLITES EUROPA AND TITAN BY HIPPARCOS

J.-E. ARLOT(1), A. BEC-BORSENBERGER(1), G. DOURNEAU(2)
(1): Bureau des Longitudes, URA 707 du CNRS
77 avenue Denfert-Rochereau, F-75014 Paris
(2): Observatoire de l'Université Bordeaux I
avenue P. Sémirot, F-33000 Floirac

ABSTRACT. Observations of the satellites Europa and Titan will be obtained from the European Astrometric Satellite HIPPARCOS. These observations will be used to obtain "observed" positions of the planets Jupiter and Saturn; these positions have the advantages, first to be given in the reference frame defined by the Hipparcos system, and second, the accuracy on these positions is better than the accuracy of the ground-based observations of these planets. To obtain the positions of the planets from those of their satellites, we have to take the calculated positions of these satellites by means of their ephemerides. The accuracy of the computed positions of Europa and Titan relatively to their primary is of the order of 0".1, better than the one of the direct observation of Jupiter and Saturn. An efficient comparison of the different ephemerides of these planets will be possible that way.

1. INTRODUCTION

The European Astrometric Satellite HIPPARCOS has observed the satellites Europa (of Jupiter) and Titan (of Saturn). In spite of the motion of these objects, the observation has been made as for the stars, using the ephemerides of these two satellites relatively to their primary, the used ephemerides of which being BDL82. The sky is scanned by rotating the telescope slowly around an axis which is nominally perpendicular to the two directions of observation (the acute angle between these directions being the basic angle). At the same time, this axis of rotation rotates at a constant angle close to 43° around the direction of the Sun (fig. 1). The transformation of the data obtained by Hipparcos on the modulating grid (fig. 2) are transformed by the two "consortia of data reduction". The final data will be obtained only after the end of the mission and only provisional results will be available during the next months.

2. COMPARISON WITH EPHEMERIDES

The Hipparcos data are referred to reference great circles (RGC) which define intermediate reference frames (fig.3). One RGC is identified by its pole and a corresponding epoch; it is used for objects near this reference great circle (a few degrees). The duration of validity of

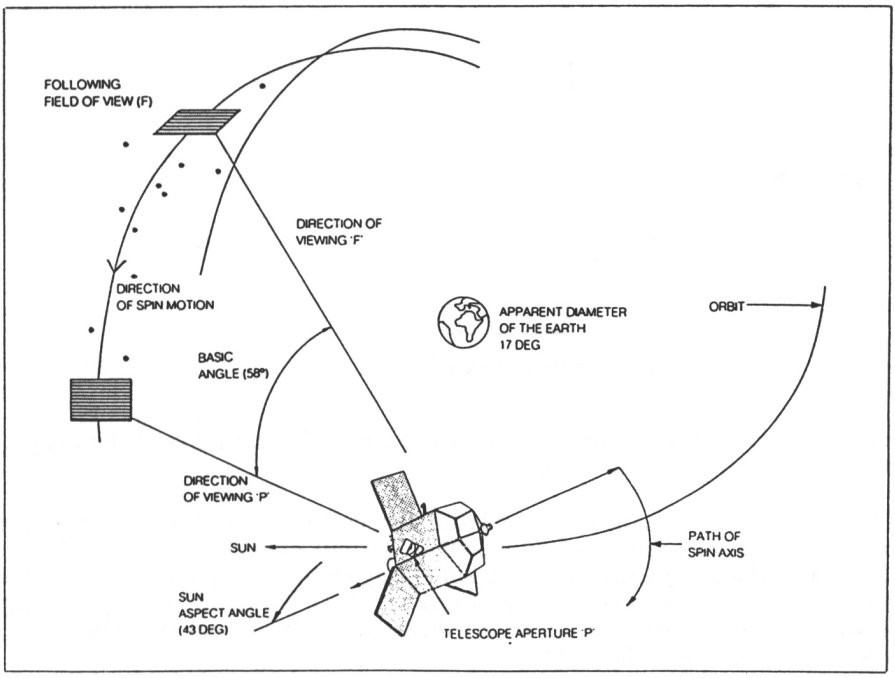

Figure 1.

such a circle is about ten hours. Grid coordinates give informations mainly on the spherical coordinate along the reference great circle, named the abscissa.

Therefore, the spherical coordinates of the planetary satellites, Europa or Titan on a reference great circle have to be calculated. This is carried out as for minor planets (Bec-Borsenberger, 1990). For an observation of a planetary satellite by Hipparcos, the reference great circle number and the "observed" abscissa are given. From this RGC number, the julian date (t1) and the modified julian date (t2) of the epoch of the observation may be obtained as well as the pole coordinates of this RGC. Then from t1, the ecliptic astrometric position of the planetary satellite is computed, and from t2, the position and the velocity of the Hipparcos satellite may be obtained. Next, the parallax, light deflection, relativistic observation corrections are to be applied to obtain precise apparent ecliptic position. Finally, by rotating the ecliptic frame to the reference great circle frame, the calculated abscissa on the reference great circle is obtained.

3. OBSERVED POSITION OF THE PLANET JUPITER

The first observations for Europa, have been made on March 13, 1990. Absolute positions of Europa have been obtained in the reference frame defined by the Hipparcos system. These positions need theoretical positions of the planet Jupiter in order to obtain (O-C), but using theoretical positions of Europa relative to its primary, one will obtain an observed position of Jupiter itself. Since the ephemerides of Europa relative to Jupiter have a better

https://doi.org/10.1017/S0252921100063776 Published online by Cambridge University Press

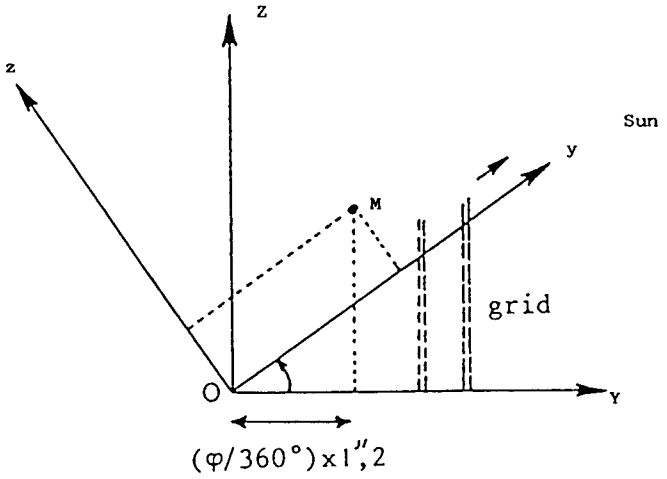

Figure 2. Illustration of the focal plane of Hipparcos. M is a point of the image of a planetary satellite; Oy is the direction of the Sun.

accuracy (near 0".1) than the ephemerides of Jupiter (near 0".4) in the J2000 reference frame, the observed position of Jupiter that we will obtain is valuable for further development. The ephemerides used are built using the following theoretical works: for Europa, theory of Sampson-Lieske (Lieske, 1977), adjusted with photographic observations (Arlot, 1982); for Titan, theoretical works recently adjusted with observations (Dourneau, 1987, 1990).

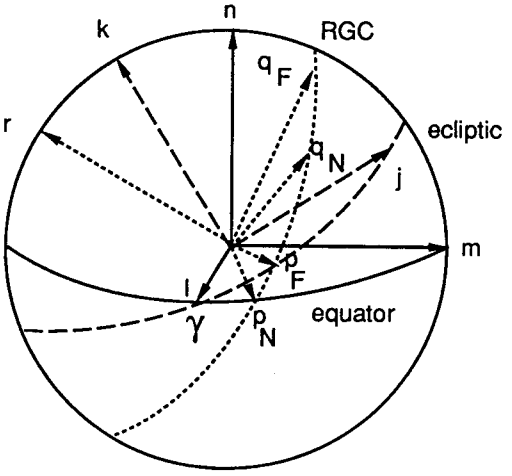

Figure 3. Reference frames for Hipparcos objects.

https://doi.org/10.1017/S0252921100063776 Published online by Cambridge University Press

4. CONCLUSION

The observation of Europa and Titan by the astrometric satellite Hipparcos will induce observational data leading to the position of the planets Jupiter and Saturn because of the accuracy of the theoretical positions of Europa and Titan (0".1) relatively to their primary. These positions of Jupiter and Saturn will be of great interest in order to make a comparison between the different ephemerides of these planets and to appreciate their precision.

REFERENCES:

Arlot, J.-E.: 1982, *Astron. Astrophys.*, **107**, 305.
Bec-Borsenberger, A.: 1990, in *Proceedings of the "Colloque Danjon"*, held in Paris, May 1990, N. Capitaine and S. Débarbat eds., Paris.
Dourneau, G.: 1987, *Thèse de l'Université Bordeaux I.*
Dourneau, G.: 1990, *Astron. Astrophys.*, to be published.
Lieske, J.H.: 1977, *Astron. Astrophys.*, **56**, 333.