THE EUROPEAN ASTROMETRY SATELLITE, HIPPARCOS

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ABSTRACT: A description of the instrument is given. It is expected to obtain positions, annual proper motions and parallaxes for 100 000 stars in a 2.5 years mission. The accuracy (s.e.) will be <±0".002 for stars of $m_B<11$ and about ±0".006 at $m_B=14$. An extension of the mission to 3.5 years would improve the annual proper motion to ±0".0010 for stars brighter than $m_B=9$.

Astrometric observations from outside the earth's atmosphere would not be disturbed by refraction, seeing, atmospheric limitation of optical resolution or by instrumental flexure due to gravity. On the other hand, technological problems of the optical system, the thermal control, attitude stabilization and data handling must be solved. Studies by the European Space Agency in collaboration with a Science Team and European industry has shown that these problems can be solved and that the high accuracy mentioned above is to be expected. Members of the Astrometry Science Team are C. Barbieri, E. Hog, J. Kovalevsky, P. Lacroute, R. S. le Poole, L. Lindegren, C. A. Murray, K. Poder and F. Scandone.

The optical system is shown in Fig. 1 and the spacecraft in Fig.2. It will be launched into a geostationary orbit and it will spin at 10 revolutions pr 24 hours, so that the two telescope axes will scan nearly the same great circle. Stars will be observed according to a list while they cross a system of parallel slits, Fig.3. The small spot of the image dissector will follow a star for a fraction of a second, then another star, and then back to the first one. An analysis of the recorded photon counts in a ground-based computer will, at first, determine the distance of the star from (say) the centre slit as a function of the recorded time. Next, these angular measurements from a few consecutive scan circles will determine the projection of the stars on a reference great circle, together with instrumental parameters e.g.the very stable basic angle between the two axes defined by the double plane mirror, besides the scale and orientation values of the grid.

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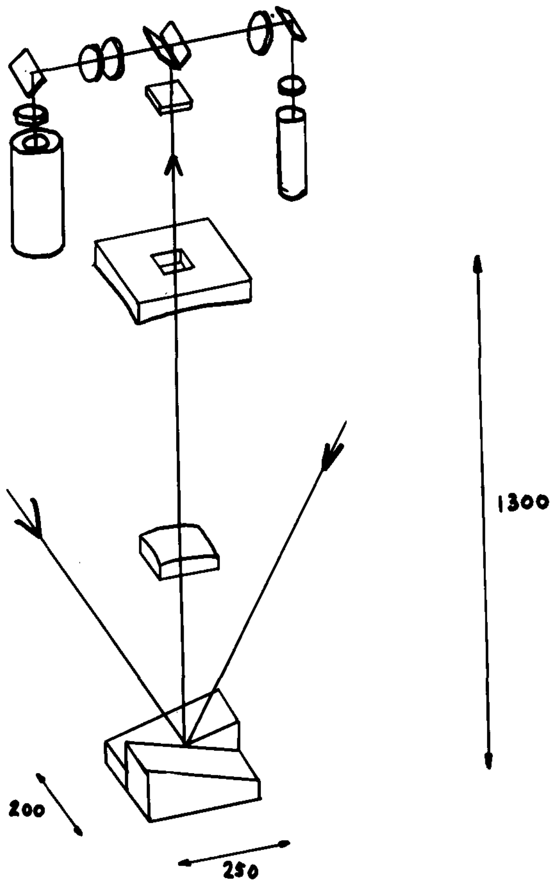

Fig.1 Hipparcos, optical and detection

The relatively large width of the dark space between each narrow slit is optimal for the detection of double stars and at the same time the mean error of single star positions is only 20 percent larger than if the width had been optimized for single star measurement. About 20 percent of the stars on any observing list will be at least partly resolved as doubles on this grid. Lindegren has given a study of this problem in the reference.

The attitude of the telescope in space must be known within two arcseconds in order to position and to move the cathode spot along with each star. This real-time attitude knowledge is obtained from observation of stars by the coarse star mapper, Fig.3, and from frequent readings of the gyroscopes. The attitude motion will be controlled by reaction wheels.

The final reconstitution of the attitude is an integral part

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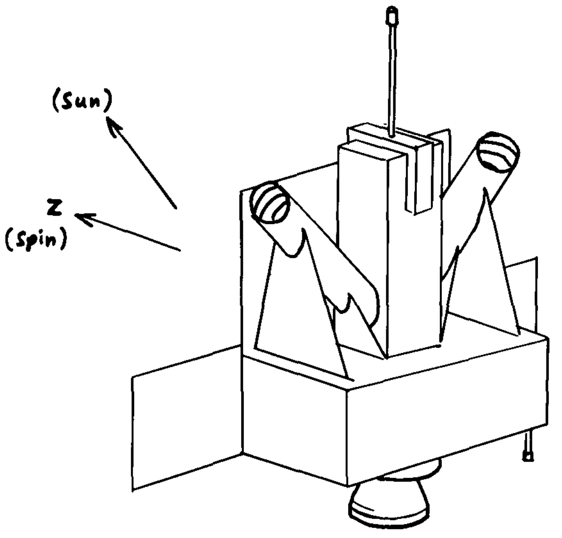

Fig.2 The spacecraft

of the data reduction to derive the astrometric parameters for all stars. The readings of gyroscopes and of the coarse star mapper are in particular required to derive the distance of the two optical axes from the reference great circle.

The attitude motion selected to ensure the best separation for each star of the two coordinates, the two proper motion components and the trigonometric parallax is a so-called revolving scanning. The spin axis is close to the normal to the two optical axes, and it points at a constant angle of (preferably) $\xi=40^{\circ}$ from the sun. Furthermore, the spin axis revolves uniformly around the sun at a rate about $K=270^{\circ}/\xi$ times per year, cf. figures 2 and 4.

The reduction of the observations by least squares in a three-step process described by Lindegren is a feasible, albeit cumbersome job. The celestial coordinates will be obtained in a very rigid coordinate system. The rotation parameters of this system must be determined by other methods e.g. by recourse to FK5 or to quasars.

The astrometry mission has the opportunity to be approved by ESA early in 1980. If this happens the launch could take place in 1985, and the final catalogue be available in the late eighties.

An informal inquiry to astronomers about projects they would propose with the astrometric data of the 100 000 stars has

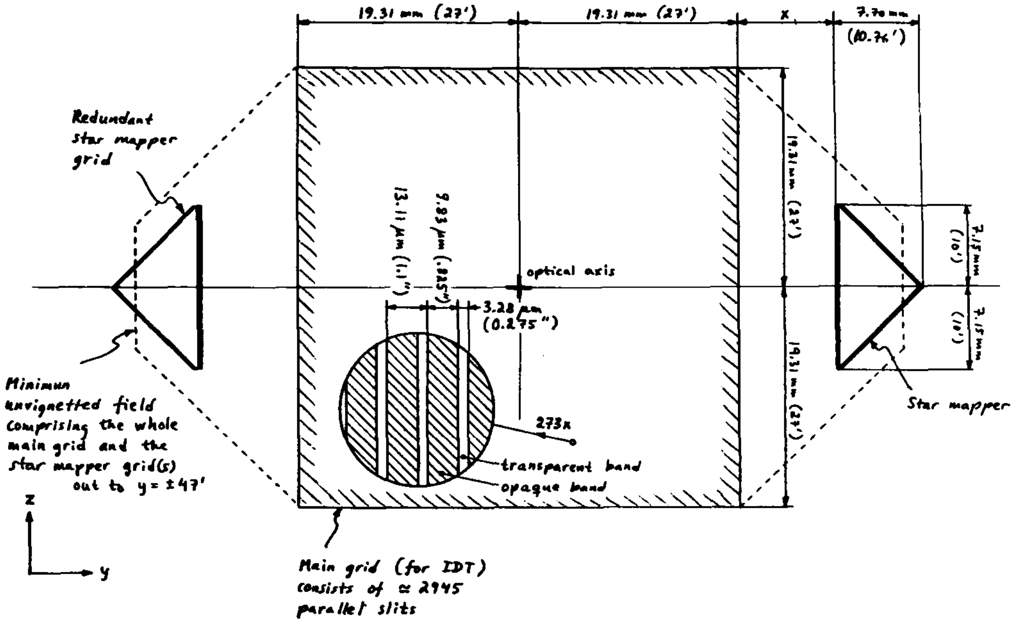

Fig. 3 Main grid and star mapper configuration

resulted in 150 projects from 125 scientists. It appears that the scientific impact of the astrometric observations on astrophysics would be both enhanced and accelerated if improved astrophysical data of the same stars would be obtained at the same time.

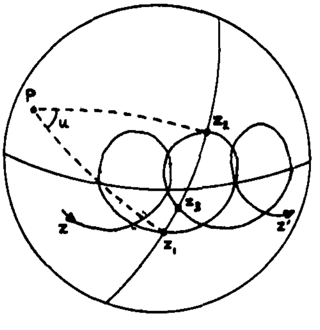

Fig.4. Path of z axis for revolving scanning with $K=270^{o}/\xi$. Observation of star at P is possible when the z axis is at z_1, z_2, or z_3

ACKNOWLEDGEMENT

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REFERENCE

Colloquium on European Satellite Astrometry, 1979, edited by C. Barbieri and P.L. Bernacca, Instituto di Astronomia, Universita di Padova, from where the 300 pages volume may be purchased.

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