USING THE HUBBLE SPACE TELESCOPE TO RELATE THE HIPPARCOS AND EXTRAGALACTIC REFERENCE FRAMES

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ABSTRACT. The HIPPARCOS satellite will produce positions, motions and parallaxes of celestial objects with previously unattained accuracy. This HIPPARCOS Instrumental System, however, will have an unknown solid body rotation with respect to an inertial reference frame. One aspect of our program of astrometric observations with the Hubble Space Telescope is to determine the rotation of the HIPPARCOS reference frame with respect to an extragalactic reference system.

The European Space Agency plans to launch an astrometric satellite (HIPPARCOS) to establish the most accurate relative stellar coordinate system of positions and motions ever determined. However, the HIPPARCOS system must be tied to an extragalactic (VLBI) reference frame to be used for studies of physical motions of objects and for the studies of relativistic effects.

The Hubble Space Telescope (HST) will provide a means of accurately measuring the relative positions and motions of bright objects with respect to faint ones in a small field of view. The expected accuracy (0.002 arcsec, rms) is an order of magnitude better than the accuracies obtained by current optical techniques for the same measurements.

Ninety one extragalactic optical objects (EGOs) in the vicinity (angular separation less than 18 arcminutes) of 160 HIPPARCOS stars (mostly SAO stars brighter than 10.5), evenly distributed over the sky, have been selected to be used to tie the HIPPARCOS system to the Extragalactic Reference Frame. The pairs are to be observed with the HST Fine Guidance Sensors (FGS), sometimes in conjunction with the HST Planetary Camera, in order to determine the relative positions and motions of the individual HIPPARCOS stars with respect to the EGOs.

In order to insure that the observations will be made and will be of use to the HIPPARCOS project, several conditions must be met:

A) The stars have to be within one FGS field of view of an extragalactic object (about 18 arcminutes along the longest dimension). Therefore, a region around each prospective EGO was searched for Smithsonian Astrophysical Observatory (SAO) stars, and for other, non-catalogued suitable anonymous stars.

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B) The extragalactic objects must be observable by HST. The limiting magnitude of the FGSs is nominally 17th. However, by using a mode of observation which incorporates Planetary Camera exposure of the "targets" and with the astrometric information from the Guide Stars, fainter EGOs may be reached. From more than 500 candidates, for which accurate positions, flux densities, optical identifications, and radio visibilities from the VLA and VLBI were available, 91 EGOs were finally chosen.

C) The EGO-HIPPARCOS star pairs must be evenly distributed on the sky. To this end, many "old favorite" radio sources were not included because an EGO-HIPPARCOS star pair in the same region of the sky was deemed more suitable.

D) The EGOs should be optically identified radio sources with compact cores which allow them to be included in the radio reference frame derived from VLBI observations. When possible, the EGOs were selected from the IAU list of recommended Radio Source Position Standards. In some cases, the only object bright enough to observe in a particular part of the sky was a radio quiet EGO. Such objects were included because of their usefulness in determining the rotation of the HIPPARCOS system independently of the radio reference frame.

E) The stars must be bright enough to be observed with HIPPARCOS (i.e. brighter than about 12.0, and brighter than 10.5 for full accuracy). The initial selection was made from the SAO catalogue, using a computer search around candidate EGOs. Other EGOs were measured on the UTRAO Laser Measuring Engine and positions of candidate stars determined from glass copies of the National Geographic Society, Palomar Sky Survey, at the University of Texas.

F) The stars must be included in the HIPPARCOS INPUT CATALOGUE (INCA) in order to be observed by HIPPARCOS. An initial selection of 414 stars was submitted to the HIPPARCOS project in 1982. This program was given the highest priority by the HIPPARCOS project; the southern extension was a major undertaking in support of the HST program. We have worked closely with various elements of the HIPPARCOS project to determine which of the stars will be included in the final catalogue.

G) Since the FGSs are interferometers, the objects must be small enough in angular extent to be observed with the FGSs. A massive program of Speckle Interferometry in the northern and southern hemispheres on as many of the 414 stars as possible has been conducted. These observations have shown that most of the stars in the final list of 160 are not multiple at the 0.04-0.08 arcsec level.

The final output from this work is the inclusion of the program objects in both the HST and the HIPPARCOS programs of observation.

Using this technique, we hope to make the most accurate determination possible of the motion of the HIPPARCOS system with respect to the extragalactic reference system.

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