TOWARDS THE DEFINITION OF A UNIFIED CELESTIAL OPTICAL/RADIO REFERENCE FRAME

K. J. Johnston, J. Russell
E. O. Hulburt Center for Space Research, Naval Research Laboratory, Washington, DC 20375-5000
Ch. de Vegt, Hamburger Sternwarte
J. Hughes, United States Naval Observatory
D. Jauncey, G. White CSIRO
G. Nicholson, Hartebeestok, S. A.

ABSTRACT. An almost inertial celestial reference frame based upon extragalactic sources is in the process of being established. This reference frame is to be global with a minimum density of one source/100 square degrees. The source positions will be based upon radio observations and will allow optical reference frames to be related to this frame at the 0.03 arc second level.

1. INTRODUCTION

Radio astrometry has made great progress in the past ten years in making accurate positional measurements over large angles. The accuracy of these measurements now appears to be approaching a milliarcsecond. Objects such as extragalactic radio sources make excellent reference points for establishing a reference frame as they should display little or no detectable proper motions.

2. THE PRESENT STATUS OF CELESTIAL REFERENCE FRAMES

The optical reference frame, the FK5, contains about fifteen hundred bright stars located over the celestial sphere and some three thousand fainter stars. The positions of the brightest stars are believed to be known to 0.03 arc seconds at the mean epoch which is about 1950 for most of the stars. The uncertainty in proper motion is estimated at 0.001 arc seconds/year so that at 1987 the apparent positions should be accurate to 0.05 arc seconds.

The radio reference frame has yet to be established. There are various catalogs of from twenty-five to over one hundred extragalactic objects (Robertson et al. 1986; Ma et al. 1986; Fanselow et al. 1984) which report positional accuracies of less than a few milliarcseconds. The majority of the sources are located in the northern hemisphere with some objects having declinations as low as -40 degrees.

3. PROGRAM PLAN

The program is aimed at establishing a reference frame of four hundred or more objects giving a density of at least one source/100 square degrees. The objects will be extragalactic radio sources which display optical emission. The positions will be determined by the radio

M. J. Reid and J. M. Moran (eds.), The Impact of VLBI on Astrophysics and Geophysics, 317–318.
© 1988 by the IAU.

https://doi.org/10.1017/S0074180900134825 Published online by Cambridge University Press

observations. These objects will be selected from the list of radio/optical candidates put foreward by IAU Commission 24 (Argue et al. 1984) and supplemented by other flat spectrum objects chosen from the Parks and Green Bank-MPI surveys.

Optical observations will be carried out using wide field astrograph cameras such as those located at Hamburger Sternwarte in Germany and Black Birch Astrometric Observatory in New Zealand and large 4 meter class prime focus photography. The astrographs will allow a large number of stars to be used to relate the position of the extragalactic radio source on the prime focus plate to the bright stars making up the optical reference frame. The accuracy of the relationship of the extragalactic radio source's position to the stars on the astrograph plate should be better than 0.03 arcseconds. For objects too faint for prime focus plates, CCD observations will be used as was the case for 1928+738 (de Vegt et al. 1987). In this way the positions of the extragalactic sources in the optical reference frame can be determined.

Observations will be obtained over a five year period beginning in July 1987. The radio observations from this campaign will be analyzed for self consistency with observations of all candidate objects obtained at least once a year in the northern hemisphere and observations obtained in the southern hemisphere when possible. The radio positions of sources down to declinations of -40 degrees should approach an accuracy of a milliarcsecond while those south of this declination may be degraded by factors of from 2 to 10. The optical observations will require a minimum of two prime focus plates per source and two wide field astrographic plates of the star field around the source. The optical observations should be on the optical reference frame to an accuracy exceeding 0.05 arcseconds globally.

The radio positions of the objects will be used to establish the reference frame and will be adopted as the positions of the objects. We are assuming that the optical and radio photocenters of the objects are coincident to the measurement accuracies of the reference which will be a few milliarcseconds. The relationship of this reference to the FK5 (or any other optical system, e.g. HIPPARCOS) frame can then be obtained to the accuracy of the optical plate transfer from the 4 meter prime focus plates to the astrograph reference stars (which will be of order less than 0.03 arcseconds). This should allow alignment of radio and optical images at this level which is about one half an Airy Disc of the Hubble Space Telescope.

4. REFERENCES

Argue, A. N. et al.: 1984, Astron. & Astrophys., **130**, 191.
de Vegt, C., Schramm, J., and Johnston, K. J.: 1987, Astron. J., **93**, 261.
Fanselow, J. L., Sovers, O. J., Thomas, J. B., Purcell, G. M., Cohen, E. J., Rogstad, D. M., and Skjerve, L. J.: 1984, Astron. J., **89**, 987.
Ma, C. et al.: 1986, Astron. J., **92**, 1020.
Robertson, D. S., Fallon, F. W., and Carter, W. E.: 1986, Astron. J., **91** 1456.

https://doi.org/10.1017/S0074180900134825 Published online by Cambridge University Press