the cluster, the surface densities of the dark squares were computed for successive distances from the centre of the cluster. Below each distribution map is the surface density curve for the dark squares; it shows, consequently, the variation of the surface density (D) with the distance from the centre of the cluster expressed in mm on the plate (r).

In figure 2 the distribution map for the cluster NGC 2547 (OCI–753) is reproduced. The circle in the centre of each map indicates the apparent extension of the cluster and the scale of each map is indicated by a horizontal line having the length of 10 mm on the ESO plates (~ 11 arcmin).

Dust and Cluster Age

For the statistical investigation only 28 clusters could be used. The *intensity* of absorption (a), expressed in an arbitrary measure, the *distance* of the absorption zone (that is the maximum of the surface density curve) from the centre of the cluster, with the radius of the cluster as the unit (d) and the *relative* absorption within the cluster, expressed as the ratio between the average surface density for the dark squares within the cluster and that for the whole region (D_c), were studied in the relation to the age of the clusters.

The clusters were, consequently, divided into four groups according to age (log t; t in years) and for each group the mean values of the above-mentioned quantities were computed. The results are given in figure 3, which is self-explanatory. The mean value of each group is represented by a black dot and error bars represent the mean error of the mean.

As shown in the figure, there is a slight indication that the intensity of absorption as well as the distance of the absorption zone from the centre of the cluster increases with the age of the cluster, whereas the absorption within the cluster decreases with increasing age. (The same result

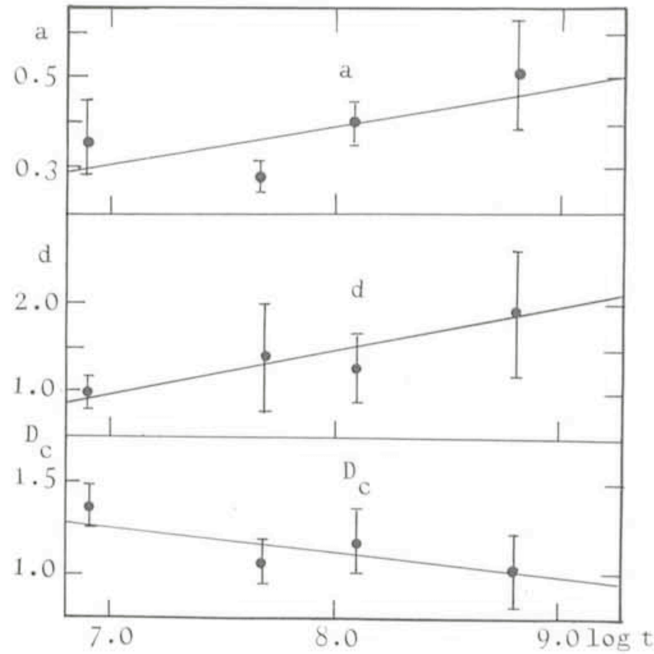

Fig. 3: *The variation of the intensity of absorption (a), the distance of the absorption zone from the centre of the cluster (d) and the absorption inside the cluster (D_c) with the age of the clusters (log t).*

was found in an earlier investigation on dark matter in open clusters mainly situated in the northern sky.

Taking into account the small number of clusters investigated as well as the large mean errors, the result cannot be regarded as fully conclusive. It nevertheless gives an indication that the dark matter (dust) has been driven away from the cluster and that the remaining dark matter inside the clusters has decreased with increasing age.

Astrometry of the Optical Images of Some Southern Radio Sources

H. G. Walter and R. M. West

Radio interferometry has enriched positional astronomy with extremely accurate celestial coordinates of extragalactic sources. As these objects are ideal points for an inertial reference frame, the problem of measuring the positions of optical counterparts with high accuracy is of central importance. Drs. H. G. Walter, Astronomisches Rechen-Institut, Heidelberg, Fed. Rep. of Germany, and R. M. West, ESO, recently measured 41 objects in the southern sky with the ESO S-3000 measuring machine. Several new identifications and improved optical positions resulted from this undertaking.

Radio Sources and their Optical Counterparts

Like stars of bright and intermediate magnitudes, selected extragalactic objects are very useful objects in astrometrical observing programmes aiming at the establishment of a general reference system of positions and proper motions. Due to their large distances, galaxies have proper motions which amount to 0.″00002 per year at most and which are therefore negligible over centuries, even in case of precise observations with present high-performance instruments. The absence of proper motions makes galaxies and other very distant objects the natural representatives of a stable reference system.

The astrometrical, optical observing programmes of galaxies that were executed during previous decades did not arrive at results which were satisfactory in every respect, because most galaxies are diffuse and extended objects and are therefore difficult to measure. For this reason, the astrometric connection of galaxies to the stars of the Fourth Fundamental Catalogue (FK4)—which constitutes the traditional, fundamental positional reference system—did not result in an accuracy exceeding that of the fundamental stars.

However, more favourable conditions for the connection of extragalactic objects to the FK4 now exist since coordinates of radio sources with *point* structure, located at large distances, are measurable with an accuracy of about 10^{-2} arcsec by means of *radio interferometry*. A careful estimate of the state of the art predicts that accuracies of 10^{-3} arcsec may be obtained in the near future, after improvement of the measurement techniques and of the data reduction methods. Thus, the radio emission at a few cm wavelength now promotes certain radio galaxies and, in particular, the radio-emitting quasi-stellar objects (QSO's) to ideal objects for the establishment of an extragalactic reference frame.

With the radio interferometrical determination of radio source positions, however, only a partial result is achieved until the optical identification of these objects has been ascertained. The identification of optical counterparts of radio sources serves the following purposes:

(1) examination of the morphological structure of the objects in order to decide their nature and whether they are suitable as reference points;

(2) tying the radio reference frame to the traditional fundamental system of positions by measuring the positions of the optical counterparts relative to stars of the fundamental system (closely related to this task are the attempts to improve the optical and dynamical reference frames on the basis of the excellent position accuracies attainable by radio interferometry);

(3) estimates of distances to extragalactic radio sources from the measured redshift of optical counterparts. (Note that so far there is no general method which yields distances from radio observations only.)

These three objectives have largely provided the motivating force for astrometry of extragalactic radio sources with point structure.

Position Measurements

At present, hardly more than two hundred extragalactic radio sources have been observed, for which the optical counterparts are known with positions accurate to a few tenths of a second of arc. Since the share of the southern sky in this number is comparatively low, we selected a group of 42 extragalactic radio sources with excellent radio positions in the southern hemisphere. When the sources had been identified with an optical counterpart, we measured their positions relative to reference stars of the Perth 70 Catalogue which is based on the system of FK4, cf. *Messenger* No. 11, p. 4.

For one of the radio sources no optical identification was found. The remaining 41 sources include three new optical identifications which are associated with the sources 1144–379, 1245–197 and 1313–334, as shown in figure 1. Finally, we succeeded in determining an improved optical position of the radio source 0438–436 which is the quasar with the highest known radio luminosity.

The measurements were made by means of ESO (B) Atlas (Schmidt) plates for sources south of declination –17°.5 and POSS Atlas plates for sources north of –17°.5. After identification of *all* (25 to 30) stars of the Perth 70 Catalogue on the plate, the (X, Y) positions of these stars and the optical image of the radio source in question were

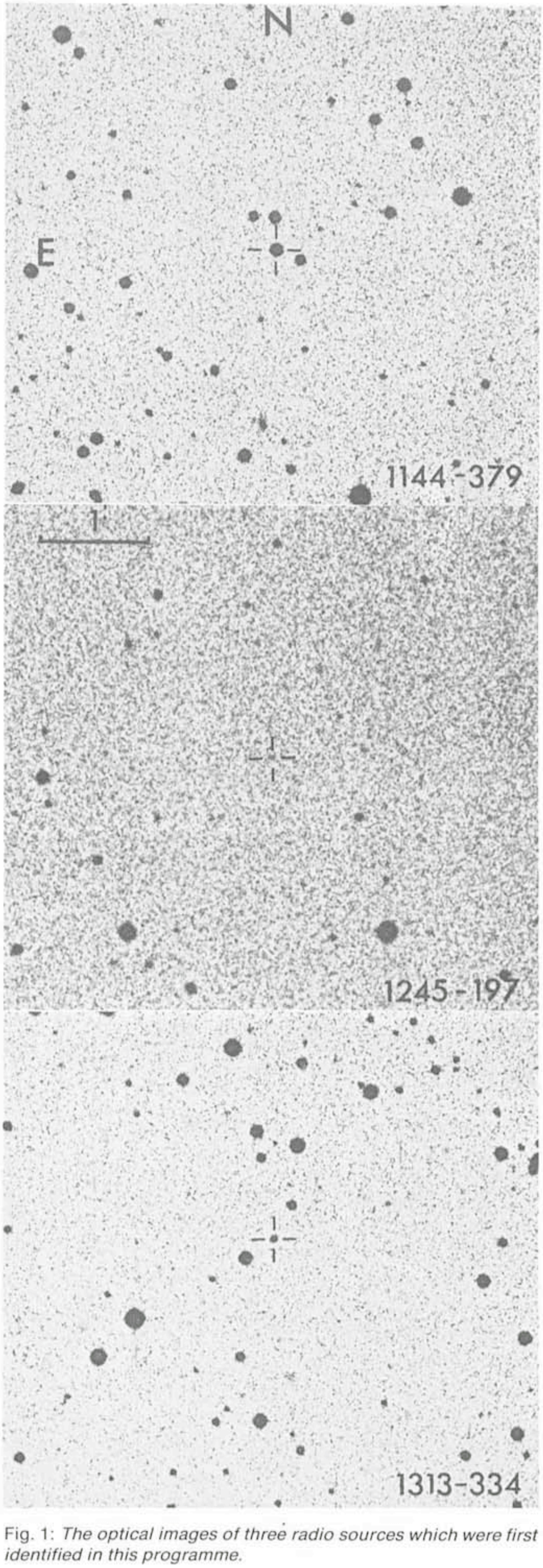

Fig. 1: *The optical images of three radio sources which were first identified in this programme.*

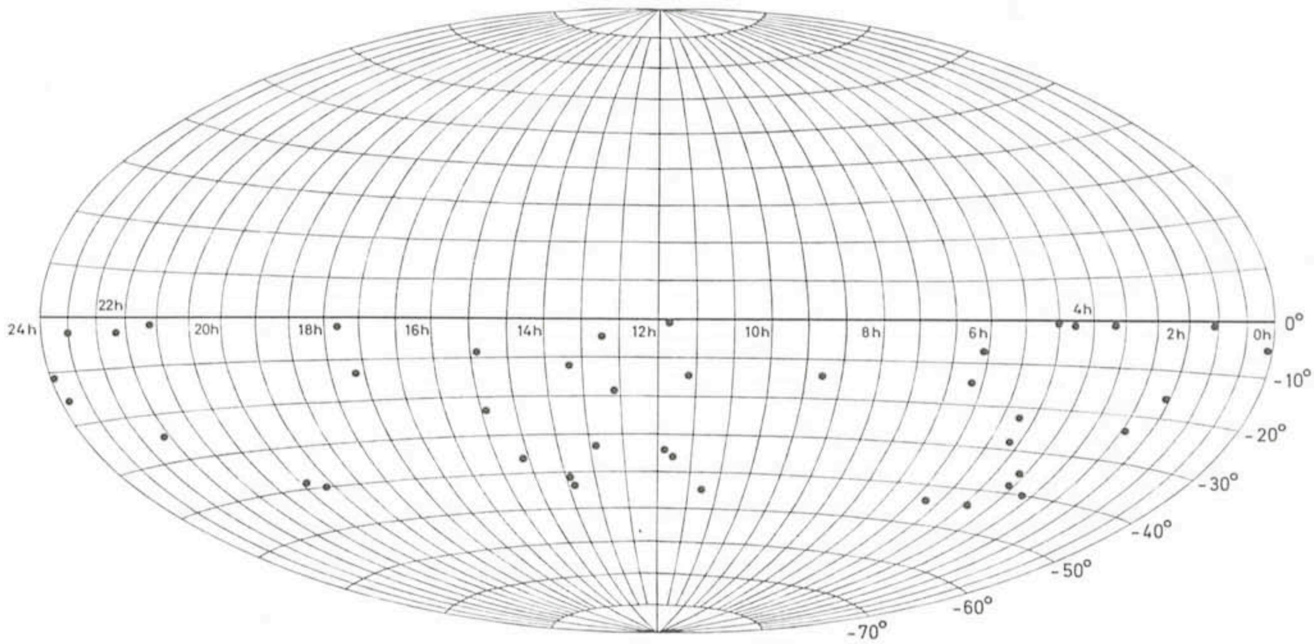

Fig. 2: *The distribution of 41 extragalactic radio sources which were measured in this programme.*

measured on ESO's S–3000 plate measuring machine. The (X, Y) positions of the reference stars were reduced to equatorial coordinates by using seven terms in both coordinates for the determination of the plate constants. Then the sky coordinates of the optical counterparts were derived with an internal average standard deviation of 0.″3 in right ascension and declination. The distribution of the measured objects over the southern sky is illustrated in figure 2. The measured optical positions agree very well with the radio interferometric positions; a full discussion is given in ESO Preprint No. 59.

Future Prospects

As most of the optical counterparts are fainter than $m_v = 16$ and since the reference stars of the Perth 70 Catalogue are brighter than $m_v = 10$, the accuracy of the present method that directly relates the counterparts to Perth 70 reference stars is limited by the large brightness difference (i.e. the appearance of the images on the plates). Superior accuracies of $\pm$ 0.″1 may be reached through a different method which ties optical counterparts to a catalogue of bright stars in a defined system by a step procedure that uses secondary reference stars in the magnitude range $12 < m_v < 14$ and long-focus, small-field plates (e.g. Chr. de Vegt, U. K. Gehlich, *Astron. and Astrophys.* **67,** 1978, p. 65). The effort, however, is disproportionately larger than direct tying on large-field Schmidt plates as we did, because the accurate positions of 50 to 100 secondary reference stars in the vicinity of each of the optical counterparts are required. So far the facilities for position measurements of secondary reference stars in the southern sky have been poor, and our method of direct tying is more expedient.

In the framework of the Space Astrometry Project sponsored by the European Space Agency (ESA), photoelectric determination of the positions, proper motions and parallaxes of about 100,000 faint stars down to the magnitude $m_v = 12$ is planned by means of an artificial earth satellite (HIPPARCOS); cf. *Messenger* No. 16, p. 35. Positional accuracies of 0.″002 are likely to be achieved. These stars would establish a comprehensive and impressively precise reference frame for position determination of optical counterparts by yielding accuracies comparable with those of radio interferometry. For practical applications, however, it is important that sufficient reference stars are measured in the fields of optical counterparts of point-like radio sources. A selective observing programme of the astrometry satellite is therefore necessary.

Main Results

The new astrometric observations of optically identified radio sources constitute a significant contribution to the network of reference points in the southern sky; we also believe to have demonstrated in practice the great utility of the Perth 70 Catalogue as reference frame for extragalactic objects and, last but not least, the reliability of ESO's plate-measuring system and the associated software (see also this issue, p. 21).

NEWS AND NOTES

Minor Planet Discovered by ESO Night Assistants

During a recent visit to Europe by the astronomer-in-charge, H.-E. Schuster, the smooth running of the ESO Schmidt telescope was assured by night assistants Oscar and Guido Pizarro. Checking through a night's plates they came upon a comparatively bright planet trail. They marked the trail and were able to find trails of the same planet on further plates that were taken for the same programme the following nights.

The first plate was taken on May 19, 1979 and the new planet has been given the preliminary designation 1979 KA. Further observations were obtained on three otherwise useless nights in June and a preliminary orbit has been computed by the Minor Planet Bureau. The mean distance from the Sun is about 400 million kilometres and the size of the new planet is probably about 10 kilometres in diameter.