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PRESENT STATUS OF ASTROMETRY

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In the history of astronomy the last two decades of the 20-th century will probably be remembered by the birth of a new astrometry.The main events which marked these decades are the successeful implementation of inertial reference frame using the positions of extragalactic radio-sources, provided by the Very Long Baseline Interferometry (VLBI) and the reference frame defined by the positions of $\approx$ 120 000 stars of our Galaxy, observed by the first astrometric satellite HIPPARCOS (launched August 8, 1989).These events have shown that the limits of the present astrometry precision and accuracy of star positions and annual proper motions have shifted below 1 - 2 miliseconds of arc (*mas*).

Besides VLBI programs, the Lunar Laser Ranging (LLR), the Satelite Laser Ranging (SLR) and the Global Positionig System (GPS) programs have also demonstrated the capability of modern astrometry to set up terrestrial reference frames and their link to the extragalactic one at 1 *mas* level of accuracy.

Astrometric prospects are highly optimistic for years to come. After the successeful HIPPARCOS mission it is quite realistic to believe that the future satellite missions will be able to realise the programs involving positions,proper motions,radial velocities,paralaxes, apparent magnitudes,... for millions of stars.Of course, the expected accuracy will surpass that attained by HIPPARCOS. Having in mind that each absolute catalogue of several hunderds of star positions or each differential catalogue of one to several thousands of star positions, determined with classical meridian circles,results from long hours of hard human work in the course of several years and having in mind that typical accuracy of these catalogues is of the order of tenths of arcseconds, it becomes evident that the classical astrometry is living its last years.

The step-wise progress in observational domain was accompained by conceptual changes. So it became clear that the concept of dynamical realisation of an inertial celestial reference system is less appropriate than its kinematic realisation, based on the assumption that the global rotation of several hunderds of quasars and other distant radio-galaxies,is negligible with respect to the attained observational accuracy.

The important conceptual step is the definition of the inertial reference system in the framework of General Relativity.The proper times of different space-time coordinate systems are now defined as the function of the velocity of the system and the sum of the global potential of the ensemble of bodies defining the system and the external potential.

The results collected during the centuries-long ground-based astrometry represent the precious heritage for the studies of long-term phenomena in our planetary system and beyond.Because of that the main efforts of astrometrists today are focussed on the realisation of an accurate link between FK5 -the current international reference frame- and the frame of extragalctic radiosources which is already in use in many astrometric, geodetic, geophysical and space navigation programs.For this purpose many methods are proposed.Without intention to establish any hierarchy of these methods,let me now mention only three.The others will be discussed later.

The positions and proper motions of radio-stars of our Galaxy will be determined together with the positions and proper motions of FK5 stars by the HIPPARCOS program. Thus, the accurate positions of radio-stars in FK5 frame will be known.On the other hand,these stars are simultaneousely observed by VLBI in conjunction with extragalctic radio- sources.Therefore, their positions in the extragalactic frame and FK5 frame represent the VLBI-HIPPARCOS link between these frames.

Another method uses automatic meridian circles for differential observations of brighter quasars (12 - 13 magnitude) and stars of our Galaxy in FK5 system.Accordingly, the direct link works, but the problem lies in the small number of quasars which are within the scope of meridian circles.

If the positions of stars in the vincinity of radiosources are determined in FK5 system (by meridian circle observations), using the wide-angle astrographs one can obtain the image of fainter quasars with the stellar background.Thus, by two steps one can establish the link between FK5 and extragalactic reference frame.

The end of 20-th century is also characterised by the massive observations of stars and planets with automatic meridian circles (AMC), new astrolabes (NA) and the other modernised instruments with the photoelectric or CCD registration.The experiments with optical interferometer are particularly promising:the expected accuracy is even 1 mas!

Automatic meridian circles, operating in Canaries,Tokyo, Bordeau and Washington produce almost yearly the differential catalogues of tens of thousands of star positions, whose accuracy beats the classical one by a factor 2-3 and more.Thanks to new micrometers and new devices for the circle reading, the observations are fully automatic,the fainter stars have become observable (up to 12-13th magnitude), the secular, seasonal and even diurnal variations of circle divisions have become controlable, etc. Massive and simultaneous observations of stars, planets and minor planets in FK5 system allow improved positions of mean equator and equinox at the conventional epoch J2000.0.

The new astrolabes, designed in France and China, have photoelectric or CCD registration with a possibility of observations at several almuncantars.Thus, observations of the Sun are possible along the whole of its orbit.Besides, the observations of other planets and brighter asteroids are used for improving the dynamical reference system.

The radiometric ranging of Mercury, Venus and Mars during the last 2-3 decades provides the database for the computation of their orbits with the fascinating accuracy. These results are also exploited for the determination of the space orientation of the conventional celestial reference frame.

The progress in clock technology and technology of clocks' synchronization ensures

a permanent increase in precision and accuracy of the modern astrometric methods.

The numerical integration of planetary motions, elaborated at Jet Propulsion Laboratory (JPL), in Passadena (U.S.A.), has shown its superior performance with respect to the classical (analytical) method.

Several improvements of the geophysical Earth's models, taking into account the contributions of the atmosphere and oceans,do not satisfy the observational accuracy.This work has not been completed yet and new set of nutations has to be internationally adopted.

The crowning result of long-lived ground-based astrometry (classical astrometry) is the fundamental catalogue FK5 . It represents the best *realisation of the celestial system of reference* (so called *conventional celestial reference frame*) by means of classical astrometry. The mean precision of star positions and annual proper motions is: $0".02$ and $0".0008$, respectively (Kovalevsky 1989). Besides, this frame is not free of regional systematic distortions whose amplitudes attain $0".1$ (Morrison et al.1991). The unavoidable errors of proper motions, precession and nutations diminish its quality with time and generate rotational terms in the motions of bodies which are described in this reference frame. Even with these results astronomy was the science of fascinating discoveries. Modern astrometry, whose accuracy today is 1 - 2 mas (even better in many segments) opens the new horisons in our understanding of the universe, that may be surprising.