Astrometry and optics during the past 2000 years

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2011.05.03: (update of the version from November 2008)

ABSTRACT: Photoelectric astrometry began with an experiment in 1925 and ended with the Hipparcos satellite mission in the years 1989-93. This period was discussed in reports placed on my website in 2008, including my proposal in 1992 for CCD astrometry with a scanning satellite called Roemer, which led to the Gaia mission due for launch in 2013.

In April 2011 links to further reports on Hipparcos, Roemer and Gaia and some new lectures were placed at www.astro.ku.dk/~erik/History2.pdf . All the files from 2008 and 2011 are available individually through the index file:
www.astro.ku.dk/~erik/erik-hoeg-history-of-astrometry-1104-index.pdf

The *big* file with the reports from 2008 at www.astro.ku.dk/~erik/HistoryAll.pdf of 5 MB will print on 8+94 pages. It contains tables of contents, overview with links, and all the nine reports.

The *short* file at www.astro.ku.dk/~erik/History.pdf of 4 pages contains a table of contents and an overview with links to the reports from 2008.

CONTENTS

Overview with links

No. 1 - 2008.05.27:

Bengt Strömgren and modern astrometry: Development of photoelectric astrometry including the Hipparcos mission

ABSTRACT: Bengt Strömgren is known as the famous astrophysicist and as a leading figure in many astronomical enterprises. Less well-known, perhaps, is his role in modern astrometry although this is equally significant. There is an unbroken chain of actions from his ideas and experiments with photoelectric astrometry since 1925 over the new meridian circle in Denmark in the 1950s up to the Hipparcos and Tycho Catalogues published in 1997.
www.astro.ku.dk/~erik/Stroemgren.pdf
Contribution to IAU Symposium No. 254 in Copenhagen, June 2008: The Galaxy Disk in Cosmological Context – Dedicated to Professor Bengt Strömgren (1908-1987).

No. 1A - 2008.06.10:

Bengt Strömgren and modern astrometry ... (Short version)

www.astro.ku.dk/~erik/StroemgrenShort.pdf
The same title as No. 1, but containing the short version posted at the symposium.

No. 2 - 2008.03.31:

Lennart Lindegren's first years with Hipparcos

ABSTRACT: Lennart Lindegren has played a crucial role in the Hipparcos project ever since he entered the scene of space astrometry in September 1976. This is an account of what I saw during Lennart's first years in astrometry after I met him in 1976 when he was a young student in Lund.
www.astro.ku.dk/~erik/Lindegren.pdf

No. 3 – 2008.05.28:

Miraculous approval of Hipparcos in 1980

ABSTRACT: The approval of the Hipparcos mission in 1980 was far from being smooth since very serious hurdles were encountered in the ESA committees. This process is illuminated here by means of documents from the time and by recent correspondence. The evidence leads to conclude that in case the approval would have failed, Hipparcos or a similar scanning astrometry mission would never have been realized, neither in Europe nor anywhere else.
www.astro.ku.dk/~erik/HipApproval.pdf

No. 4 - 2007.12.10:

From the Roemer mission to Gaia

ABSTRACT: At the astrometry symposium in Shanghai 1992 the present author made the first proposal for a specific mission concept post-Hipparcos, the first scanning astrometry mission with CCDs in time-delayed integration mode (TDI). Direct imaging on CCDs in long-focus telescopes was described as later adopted for the Gaia mission. The mission called Roemer was designed to provide accurate astrometry and multi-colour photometry of 400 million stars brighter

than 18 mag in a five-year mission. The early years of this mission concept are reviewed.
www.astro.ku.dk/~erik/ShanghaiPoster.pdf
Presented as poster at IAU Symposium No. 248 in Shanghai, October 2007. Only the first three pages appear in the Proceedings.

No. 5 - 2008.05.23, updated 2008.11.25.
Note in 2011: See further update in **www.astro.ku.dk/~erik/History2**

Four lectures on the general history of astrometry

Overview, handout, abstracts at: www.astro.ku.dk/~erik/Lectures.pdf
Brief overview :

Lecture No. 1:

Astrometry and photometry from space: Hipparcos, Tycho, Gaia

The introduction covers 2000 years of astronomy from Ptolemy to modern times. The Hipparcos mission of the European Space Agency was launched in 1989, including the Tycho experiment. The Hipparcos mission and the even more powerful Gaia mission to be launched in 2011 are described.

Lecture No. 2:

From punched cards to satellites: Hipparcos, Tycho, Gaia

A personal review of 54 years development of astrometry in which I participated.

Lecture No. 3:

The Depth of Heavens - Belief and Knowledge during 2500 Years

The lecture outlines the understanding of the structure of the universe and the development of science during 5000 years, focusing on the concept of distances in the universe and its dramatic change in the developing cultural environment from Babylon and ancient Greece to modern Europe.

Lecture No. 4, included on 2008.11.25:

400 Years of Astrometry: From Tycho Brahe to Hipparcos

Four centuries of techniques and results are reviewed, from the pre-telescopic era up to the use of photoelectric astrometry and space technology in the first astrometric satellite, Hipparcos, launched by ESA in 1989. The lecture was presented as invited contribution to the symposium at ESTEC in September 2008: **400 Years of Astronomical Telescopes: A Review of History, Science and Technology.** The report submitted to the proceedings is included as No. 8 among "Contributions to the history of astrometry".

No. 6 – 2008.11.25:

Selected astrometric catalogues

ABSTRACT: A selection of astrometric catalogues are presented in three tables for respectively positions, proper motions and trigonometric parallaxes. The tables contain characteristics of each catalogue to show especially the evolution over the last 400 years in optical astrometry. The number of stars and the accuracy are summarized by the weight of a catalogue, proportional with the number of stars and the statistical weight.
www.astro.ku.dk/~erik/AstrometricCats.pdf

No. 7 – 2008.11.25:

Astrometric accuracy during the past 2000 years

ABSTRACT: The development of astrometric accuracy since the observations by Hipparchus, about 150 B.C., has been tremendous and the evolution has often been displayed in a diagram of accuracy versus time. Some of these diagrams are shown and the quite significant differences are discussed. A new diagram is recommended and documented.

www.astro.ku.dk/~erik/Accuracy.pdf
The two diagrams, Fig. 1a and 1b, in black/white and colour :
www.astro.ku.dk/~erik/AccurBasic.pdf www.astro.ku.dk/~erik/AccuracyColour.jpg
www.astro.ku.dk/~erik/AccuracyBW.wmf www.astro.ku.dk/~erik/AccuracyColour.wmf

No. 8 - 2008.11.25:

400 Years of Astrometry: From Tycho Brahe to Hipparcos

ABSTRACT: Galileo Galilei's use of the newly invented telescope for astronomical observation resulted immediately in epochal discoveries about the physical nature of celestial bodies, but the advantage for astrometry came much later. The quadrant and sextant were pre-telescopic instruments for measurement of large angles between stars, improved by Tycho Brahe in the years 1570-1590. Fitted with telescopic sights after 1660, such instruments were quite successful, especially in the hands of John Flamsteed. The meridian circle was a new type of astrometric instrument, already invented and used by Ole Rømer in about 1705, but it took a hundred years before it could fully take over. The centuries-long evolution of techniques is reviewed, including the use of photoelectric astrometry and space technology in the first astrometry satellite, Hipparcos, launched by ESA in 1989. Hipparcos made accurate measurement of large angles a million times more efficiently than could be done in about 1950 from the ground, and it will soon be followed by Gaia which is expected to be another one million times more efficient for optical astrometry.
www.astro.ku.dk/~erik/Astrometry400.pdf
Invited contribution to the symposium in Leiden in October 2008:
400 Years of Astronomical Telescopes: A Review of History, Science and Technology

No. 9 - 2008.11.25:

650 Years of Optics: From Alhazen to Fermat and Rømer

ABSTRACT: Under house arrest in Cairo from 1010 to 1021, Alhazen wrote his Book of Optics in seven volumes. (The caliph al-Hakim had condemned him for madness.) Some parts of the book came to Europe about 1200, were translated into Latin, and had great impact on the development of European science in the following centuries. Alhazen's book was considered the most important book on optics until Johannes Kepler's "Astronomiae Pars Optica" in 1604. Alhazen's idea about a finite speed of light led to "Fermat's principle" in 1657, the foundation of geometrical optics.
www.astro.ku.dk/~erik/HoegAlhazen.pdf
Contribution to the symposium in Leiden in September 2008:
400 Years of Astronomical Telescopes: A Review of History, Science and Technology

Further installments in preparation: On the Hipparcos mission studies 1975-79 and on the Hipparcos archives.

Best regards *Erik* http://www.astro.ku.dk/~erik