EXECUTIVE SUMMARY OF THE WORKSHOP

The Workshop on the *'Future Possibilities of Astrometry in Space'* followed from the Horizon 2000+ Survey Committee's recommendation for *'...ESA [to] initiate a Cornerstone-level programme in interferometry for use as an observatory open to the wide community. The first aim is to perform astrometric observations at the 10 microarcsec level'*.

The GAIA concept, as submitted to the Horizon 2000+ Survey Committee, was used as a starting point for discussions on the scientific goals and technological challenges for such a mission. While the Survey Committee's recommendations have not yet been adopted, the 100 or so participants at the meeting felt that the initiative for the Workshop had been timely. What emerged was a very strong support for a new astrometry mission, broadly following the GAIA concept with, at the same time, many suggestions for extending and strengthening the scientific goals, and many ideas for the mission's technological implementation.

The general target of determining the astrometric parameters at the 10 microarcsec accuracy level (i.e., as achieved with the GAIA concept, and endorsed by the Survey Committee) was considered appropriate, both from a scientific point of view, and in terms of its technical feasibility. The GAIA 'baseline mode' expectation of 50 million objects down to about $V = 15$ mag also found strong support; but at the same time, arguments were presented for going to fainter magnitudes.

Much of the scientific session was devoted to general (and very dramatic) aspects of stellar and Galactic structure and evolution which would be addressed by such a mission: direct distance determinations to objects at the distance of the Galactic centre (and almost to the Magellanic Clouds) would be possible, and objects *throughout our Galaxy* would have individually significant kinematical motions. But in addition, two very clear, and highly dramatic scientific by-products were underlined:

• the measurement of photocentric motions can confidently be predicted to result in a screening of all 100 000 or more objects within 100–200 pc for Jupiter-type companions, and even for sub-Jupiter masses (perhaps from $10\,M_{Earth}$ upwards). This would represent a remarkable advance in our knowledge of the occurrence of planets around other stars. It would be a most significant contribution to theories of formation of planetary systems, and at the same time would provide scientific data having profound philosophical implications.

• the determination of the gravitational (parameterized post-Newtonian) light-bending term, γ, should be possible with GAIA to 1 part in $10^6 - 10^7$, depending on the final target astrometric accuracies, the total number of stars observed, and the control of systematic error terms. This prediction can be made from experience with the Hipparcos data, where light-bending by the Sun is already a very significant effect, amounting to some 4 milliarcsec even 90° to the ecliptic. This determination would provide an important contribution to present theoretical developments in gravitational physics, where departures from the general relativistic value, $\gamma = 1$, are predicted from scalar-tensor theories invoked to account, for example, for inflation.

Additionally, and more speculatively, two contributions addressed the remarkable possibility that a microarcsec-class astrometric mission *might* achieve the first indirect detection of gravity waves.

All of these exciting possibilities would be more enhanced by a higher achievable astrometric accuracy, as anticipated by the possibilities of 'direct fringe detection'. Since this would provide a fainter limiting magnitude, and at the same time greatly alleviate problems of source confusion, the possibility of achieving direct fringe detection should be seriously studied. Interestingly, the Workshop resulted in new thoughts about how this might be achieved, either building on present state-of-the-art CCD or near-IR detector technology, or incorporating more advanced detection techniques. Another important requirement that emerged from the Workshop was to investigate how far into the red the astrometric observations could be made, so as to minimise the effects of extinction for distant objects in the Galactic plane.

A variety of technical papers identified new solutions to some of the technological difficulties that this mission will face. In current space and project argot, however, there were no identified 'show-stoppers'. Nevertheless, some interesting new conceptual challenges were identified: the equations for GAIA's sphere solution would have to be formulated in a fully-developed general relativistic framework (and relativistic effects might have to be taken into account in the light propagation within the slowly spinning satellite); an improved Earth ephemeris, and a very high accuracy on the satellite's instantaneous position and velocity would be needed. The effects of our Solar System's motion around the Galactic centre, with its period of 250 million years, would be clearly measurable by such a mission. The complexities of handling such formidable quantities of data, perhaps some 100 Tbits over a five-year mission, both on board the satellite and on the ground, were also contemplated.

Faced with high-accuracy astrometric data on tens if not hundreds of millions of objects, our corresponding lack of information on related basic stellar parameters such as radial velocity, metallicity, spectral type, etc., was apparent. One strong message from the participants was that ways of acquiring these complementary data (either independently from the ground, or from space—possibly in parallel with acquisition of the astrometric data) must be seriously investigated.

The Workshop underlined the fact that a large number of scientists have demonstrated their readiness to work with ESA in embarking on this remarkable and challenging mission, if it is indeed accepted within the European Space Agency's Horizon 2000+ long-term scientific programme later in 1995. The immense scientific breadth and impact of this future astrometry mission seems to be matched by a technological challenge entirely appropriate to a future ESA 'cornerstone' programme.

The Scientific Organizing Committee, July 1995

Michael Perryman, (Chairman), ESA, ESTEC, Noordwijk
Gerry Gilmore, Institute of Astronomy, Cambridge
Mario Lattanzi, Astronomical Observatory, Torino
Floor van Leeuwen, RGO, Cambridge
Lennart Lindegren, Lund Observatory
François Mignard, CERGA, Grasse
Jan-Willem Pel, Kapteyn Institute, Groningen
Sergio Volonté, ESA, Paris

Editorial Note: The Scientific Editors note that a few papers have been included in these proceedings that were not presented at the Workshop—papers proposed, or commissioned by the Scientific Organising Committee, to fill gaps which became evident at the meeting. Three papers presented at the Workshop (those by L. Taff, R. Terlevich, and F. Vakili) were not submitted by the authors for inclusion in the proceedings. Papers submitted have been edited to improve cross-referencing and uniformity of style, and the editors take responsibility (and offer apologies in advance) for any misrepresentations that this might have inadvertently introduced.