INTRODUCTORY REMARKS

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Dear Colleagues,

The Three-Dimensional Universe with Gaia: what an appealing title for these Rencontres de l'Observatoire, which augurs how exciting will be the many new openings in astronomy and astrophysics that shall become available when the data collected by Gaia will be released!

Allow me, for a couple of minutes to return to its glorious predecessor, Hipparcos. It provided positions, yearly proper motions and parallaxes of some hundred thousand stars with a median uncertainty somewhat better than one milliarcsecond. This is to compare with the situation in astrometry at that time: an improvement by a factor of 5 to 20 of the proper motions for 90 per cent of the stars and, in parallaxes, practically for all the stars in the programme. Although the useful radius (better than 10 per cent uncertainty) was limited to 100 parsecs and concerned in majority bright stars ($M < 7$ or so), the scientific outcome was enormous as witnessed by several thousand papers that refer more or less directly to the results of Hipparcos.

Now, imagine the new jump in preparation. There will be ten thousand times more stars, which will be all observed with an uncertainty at least 4 times better than Hipparcos (200 μas). Out of them, some 40 million will be observed 80 times better (10 μas) than the Hipparcos best measurements, and all Hipparcos and Tycho 2 stars will be observed 250 times better (4 μas). The improvement is incommensurable with the jump realised by Hipparcos. I shall not dwell on all the scientific returns that are to be expected: that is the goal of this symposium, and problems that are expected to be solved by Gaia data will be presented all throughout these four days. It is sufficient to read the headlines of the programme to be convinced that they concern all the astronomical not-too-extended objects from the minor planets in the Solar System to quasars in the remote Universe.

This remarkable gain in precision and in number of objects is so large that it was tempting to devise smaller astrometric satellites, which would observe with precision half way between Hipparcos and Gaia. Owing to the fact that more than 20 years separate Hipparcos and Gaia launches, such projects were quite sensible, provided that they would have been lauched by now. But the delays, which were adding up for DIVA and FAME in front of a constant confirmation of Gaia as a major priority of ESA together with a stable launch date, (2010-2012) made these projects less and less appealing to decision makers, and finally, arguing financial or technical reasons, they aborted. And Gaia is left alone to take up the challenge to do ten thousand times better than its predecessor. One may argue that Gaia is not the only space astrometry mission to be launched. The Space Interferometry Mission, SIM, is apparently due to be launched a little bit earlier than Gaia. But there is practically no duplication in the programmes; the very accurate parallaxes that will be obtained by SIM are very small in number and concern in principle very faint objects. So, one should rather speak of complementarity rather than of competition.

Gaia is a very difficult and complex mission. On-board, in addition to astrometry, which would already demand much more effort and preparation than Hipparcos, there are two instruments that would have been adequate by themselves to constitute separate space missions: radial velocity determination for more than one hundred million stars, and wide (4 bands) and medium (11 bands) photometry, able to analyse all the objects of the mission. The great advantage is that one will get simultaneously the data in the three domains. The other great advantage is that many more astronomers are directly interested in the simultaneous outcome of the three aspects of the mission. Officially, more than 260 scientists, from Europe alone, have written letters to announce their scientific interest. Your presence here and the fact that not all the candidates could be accepted due to lack of space, is another proof of the wide interest of Gaia. Among us, there are people like me who will be too old to use the data, but most are younger people who will lead their teams and students towards sharing this almost infinite treasury. I bet that, in Europe alone, more than a thousand scientists will be actively involved in Gaia Science. All over the world, this could be five times more.

As I said, this is a very complex mission, and its preparation is a huge task that involves a wide spectrum of proficiency and cross-fertilisation. It is remarkable how many astronomers have joined the undertaking under the wise but firm guidance of Michael Perryman, our Project Scientist. The work is dispatched among 14 active working groups and some more are to be activated. Each working group consists of scientists all over Europe. Including core members and associate members, each working group includes about 30 people, but the actual member-

ship lies between a dozen and 80 persons. Each working group is assigned a certain numbers of tasks, the implementation of which is periodically discussed during meetings and the result is either software or reports. The link between the working groups is ensured by scientists who are members of several groups and, ultimately, by the Gaia Science team and the Project Scientist. Some of the contributions to the technical issues studied by these working groups will be presented during this meeting as far as they concern modelling and simulation of the instruments and data processing.

You remember the major role played by the Input Catalogue to the Hipparcos mission. It was compiled from existing data as well as from additional, specially programmed, ground-based observations. Gaia will not need the *a priori* knowledge of star positions, but an important input is still expected from terrestrial observatories or some particular space missions. They concern essentially:

1. Photometry and radial velocity data to be used by on-board calibrations;
2. Asteroids and other faint objects of the Solar System for which additional observations may be needed for object recognition and orbit determination;
3. Follow up of alerts triggered by the preliminary data reduction;
4. Modelling the galactic extinction;
5. Assessing and/or completing data for some variable stars;
6. Et cetera.

At the present stage, the most urgent task is to complete all the technical studies that were entrusted to the working groups and the many other studies that are performed through industrial contracts and, of course, in ESA itself. We are entering in the finalisation of the Gaia definition (B1) phase of this mission in such a way that subsequent phases of the realisation can start soon. Of course many minor changes and optimisations in the design were made during these years, the principle, which you all know, remains unchanged. An important section of the symposium will be dedicated to the present quasi-final characteristics, design and expected performances of Gaia. They are the base for further activities in analysing and preparing the data reduction.

One must bear in mind that the more all the foreseeable details of the data treatment are anticipated in the data reduction package, the faster the productive phase of the mission will start. In the case of Hipparcos, it took more than a year for the data reduction consortia to adapt their software to the actual satellite behaviour. And, I must say, that the change of orbit was by far not the only cause, despite of what we thought was a very good modelling. The complexity of Gaia makes the stages of modelling and writing the software for on-board and ground-based data treatment particularly crucial. It is a major challenge, and we must thank our colleagues who have undertaken these tasks and who will present their work.

The result of all this preparation that leads to an accurate description of what will be available to the outside world is essential to the scientific preparation of the mission. Many problems that should be solved by Gaia will be presented during this symposium, but now, closer and detailed description of how they should be tackled must be studied. The scientific case of Gaia is far from being finished, and much more effort must be devoted to updating it.

In conclusion, the programme of this symposium is very exciting and I shall not take more of your time but rather let you enjoy the presentations not, however, before thanking warmly Catherine Turon, Michael Perryman and Yves Viala together with all the members of the scientific and local organising committees for their splendid work in preparing this meeting.