# Science Meeting – Scientific Report

**Scientific report (one single document in WORD or PDF file) should be submitted online <u>within two months of the event</u>. It should not exceed seven A4 pages.**

*Proposal Title:* **Extragalactic Science with Gaia**

*Application Reference N°:*  5060

**1)      Summary (up to one page)**

We organized a workshop, dedicated to extragalactic science with Gaia to discuss about the future exploitation of Gaia data. This timely workshop has mainly focused on  the description of the past actions and the future actions for the most efficient exploitation of the Gaia data. We have summarized all about the software and the science investigations under DPAC, regarding the Gaia galaxies. We have also described the connection and complementarity of Gaia data to deeper and infrared surveys of galaxies.

ESA's cornerstone Gaia mission will acquire observations of a billion stars and other objects of the Milky Way, resulting in the construction of a three-dimensional stellar map of our galaxy. However, Gaia's "eyes" will be able to see further away, observing millions of Local Group stars, distant galaxies and quasars. Gaia will record the spectra of the detected extragalactic objects, but the morphological information could also be retrieved, too. Extragalactic astronomy will be highly benefited from the huge database that the Gaia satellite will obtain through its five years of operations. The proper exploitation of these data is therefore of a great importance of the astronomical community.

The galaxy spectra of the distant unresolved galaxies and the stellar spectra of the Local Group resolved galaxies will be used to predict, among others, spectral classes, redshift and extinction values and star formation history parameters, and to define key properties of star forming regions, improving our understanding of the star formation history, distance and age scales and evolution of the Universe.

The urgent pre-mission needs of Gaia and the proper future exploitation of extragalactic Gaia data require the complementary use of other space and ground-based surveys. Discovering the scientific information from these huge databases requires the implementation of advanced classification and parameterization software and galaxy evolution codes, with the aid of realistic synthetic data. Astrostatistics and synthetic galaxy templates will facilitate the exploitation of Gaia data and maximize their impact.

**2)     Description of the scientific content of and discussions at the event (up to four pages)**

The meeting had the goal to Inform the astronomical community of the GAIA mission and the expected benefits of extragalactic astronomy and specifically the following subjects, that, were discussed in detail:

- The Athens group presented their work in the context of their participation in coordination unit 8 (CU8), (M. Kontizas)
- The development and functionality of UGC, the software that will provide classification and regression data for galaxies (I. Bellas-Velidis).
- Galaxies with Gaia , (Brigitte Rocca-Volmerange, Institut d' Astrophysique de Paris)
- The participation in the GAIA-ESO survey, the aims of the survey and how it complements the GAIA mission. Description of the Athens group work within the survey, the preparation and the target selection, (D. Hadzidimitriou).
- The current status and further development of the libraries of galaxies that will be used on UGC (E. Livanou).
- A timeline presenting the necessity of developing a galaxy library, the theoretical work on which the libraries are based on, the stages of improvement and optimization of the library up to the current version. The development of software to use along with existing programs in order to obtain a realistic sample of properties from real galaxies from SDSS, (A. Karampelas).
-  The stellar content of the nearby galaxies that will be resolved in stars by GAIA and the exploitation of the relevant data, (P. Drazinos).

**A.** Astronomers with active involvement in the GAIA mission, from different coordinating units (CU), provided the workshop participants with an overview of their respective CU work covering a variety of subjects

- Quasars (Alexandre Humberto Andrei, Univ Hertfordshire, UK)
- Libraries of spectra of all objects to be detected by Gaia, (Rosanna Sordo, INAF, Padova, Italy
- The observation of extended sources by GAIA (Ch. Ducourant, LAB – Bordeaux, France, A. Martins-Krone, SIM/FC - Universidade de Lisboa, Portugal)
- An estimation on the morphology of galaxies that will be observed with GAIA (A. Martins-Krone, SIM/FC - Universidade de Lisboa, Portugal).
- Estimation of the observations of unresolved galaxies with the GAIA high and low resolution spectra (A. Martins-Krone, SIM/FC - Universidade de Lisboa).
- Gaia Alerts, Michel Dennefeld , IAP, France

**B.** Astronomers with no involvement in the GAIA so far for the mission preparation presented their interest and work on the field of extragalactic astronomy and discussed on how the data expected from the mission can be exploited or supplemented by ongoing research.

▪ Presentation of the k-means clustering method, discussion on how it can complement already used methods in the galaxy spectral classification (Jorge Sanchez Almeida, Instituto de Astrofisica de Canarias, Spain).

▪ Overview of the CALIFA survey: instruments used, the aims, already published data and discussion on the comparison of the CALIFA data and the expected GAIA data, (Jose . M. Vilchez, IAA, Spain)

▪ Discussion on statistical methods and how they can be implemented in the exploitation of GAIA data.

All these talks were attended with great interest by all the participants and very extended discussions followed each subject (see below the most important issues).

**3) Assessment of the results and impact of the event on the future directions of the field (up to two pages)**

The scope of the event was to inform the astronomical community on the Gaia mission concerning extragalactic astronomy and to provide to all astronomers with related interests the opportunity to discuss the possibilities arising from the scientific results of the mission. Moreover we investigated the strategies on how to exploit the data expected. In that context the event proved to be useful for the participants. Scientists not involved in the mission were able to be substantially informed about Gaia:

- Mission aims.
- Instruments and limitations.
- Preparation for the observations and difficulties presented along the way.
- Prepared software and methods for evaluating future observations.
- Estimation of the data that can be obtained from the mission.

The discussion's goal was the benefit by data from Gaia (throughout the event from all participants) within the ongoing projects the discussion on possible follow up observations of extragalactic targets, comparing data and evaluating statistical tools and methods developed by different parties for related fields of interest.

Perhaps the most important outcome of the event is the discussion at the final session of the event on the possibilities of a future collaboration concerning the exploitation of the Gaia data on extragalactic astronomy. The need to act collectively in anticipation of the Gaia data was acknowledged by all and the idea of forming a joint collaboration was unanimously embraced. The name of this joint effort was selected to be **"Gaia for Galaxies (G4G)"**. The scientific topics that can be investigated through this joint project and the difficulties (coordination, funding etc) of such a collective effort were proposed and assessed from the participants. A detailed list of topics that were agreed to be included in the G4G project is given below.

**G4G – Gaia For Galaxies**

Proposed topics to be included in the scientific case for a joint project:
Scientific cases
• Extragalactic sky as will be seen by Gaia (numbers to be fixed)
• Compact red galaxies
• Blue compact galaxies
• Strong emission line galaxies
• Morphology of galaxies
• Luminous red galaxies
• Brighter extension of the reference frame
• Resolved stars in nearby galaxies (?)
• Merging galaxies (?)
• Indices from Gaia spectra
• Statistical Methods for classification/parametrization
• Observational templates
• Cross correlation with existing catalog data
• Aperture effect on spectra
The meeting summary was prepared by Mary Kontizas and Rosanna Sordo


**4) Annexes 4a) and 4b): Programme of the meeting and full list of speakers and participants**

**Annex 4a: Programme of the meeting**

**Program of the meeting.**

**Thursday 17/10**
9.30-10.0     Registration
10.00-10.15    Welcome - E.Kontizas
Session I - Chair C. Ducourant
10.15-10.45    M. Kontizas,   Review of the Athens team activities
10.45-11.30    I. Bellas-Velidis,   UGC
11.30-12.00    Coffee Break
Session II - Chair M. Dennefeld
12.00-12.30    A.H. Andrei,   The Gaia QSO Initial Catalog
12.30-13.00    R. Sordo,   The Gaia libraries
13.00-13.30    D. Hatzidimitriou,   Gaia-ESO survey
13.30-15.00    Lunch Break
Session III - Chair J.M. Vilchez
 15.00-15.30    A. Krone Martins,   Galaxy morphology from Gaia data
15.30-16.00    P. Gavras,   GALFIT , MAGIL
16.00-16.30    Michel Dennefeld,   Gaia Alerts
16.30-17.00    Coffee break
Session IV - Chair  J. Sanchez Almeida
17.00-17.30    E. Livanou, Further development of the galaxy Libraries
17.30-18.00    P. Drazinos, Nearby galaxies with Gaia

18.00-18.30    C. Ducourant Extended sources with Gaia

**Friday 18/10**
Session I - Chair B. Rocca- Volmerange
10.00-10.30     J. Sanchez Almeida, What k-means does, and what k-means may do for Gaia
10.30-11.00    A. Karampelas, Spectral classification of galaxies using ACODET.
11.00-11.30     Discussion
Session II - Chair A.H. Andrei
12.00-12.30     B. Rocca Volmerange,    Galaxies with Gaia high/low resolution
12.30-13.00    J.M. Vilchez,    Comparison with integrated spectra of galaxies that have been obtained by the CALIFA survey.
13.00-13.30     Short lunch break, Working break
Session III - Chair R.Sordo M.Kontizas
13.30-16.00     General discussion, EXPLOITATION OF GAIA EXTRAGALACTIC OBSERVATIONS - Joint Project? - Concluding remarks


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