

# Scientific report of the international conference «Assembling the Puzzle of the Milky Way»

## Summary

The goal of this conference was to gather the astronomical community dealing with the Milky Way in order to exchange the newest scientific results and to address the key questions to solve the «puzzle of the Milky Way». The topics of the conference spanned a wide range from the Halo of the Milky Way, the thin and the thick disc, the galactic Bulge, star formation and interstellar medium and covered also large scale and/or dedicated observations of our Galaxy as well as different approaches of Galaxy models. It has been a starting point of assembling the international community in preparing the exploitation of the Gaia data.

**The conference was held in Le Grand-Bornand, France, on April 11-16, 2011 and gathered a total of 158 participants. Grants for students, postdocs and travel expenses for invited speakers were possible thanks to the ESF support.** Participants included researchers from 27 countries, staff, postdocs and 40 students. The website for the conference is:

<http://mw2011.obs-besancon.fr>

The meeting was a great success both from the point of view of the attendance from all over the world and the high quality of presentations (most of the talks and posters are available on the conference website).

### ***Scientific Organising Committee:***

Timothy Beers (Michigan State University, UK)  
James Binney (Oxford University, USA)  
Herwig Dejonghe (Ghent University, Belgique)  
Sofia Feltzing (Lund Observatory, Suède)  
Francesca Figueras (Universidad Barcelona, Espagne)  
Ken Freeman (Australian National University, Canberra, Australie)  
Misha Haywood (Observatoire de Paris, France)  
Amina Helmi (University of Groningen, Pays-Bas)  
Daisuke Kawata (University College London, UK)  
Xavier Luri (Universidad Barcelona, Espagne)  
Dante Minniti (Pontificia Universidad Catolica de Chile, Chili)  
Daniel Pfenniger (Observatoire de Genève, Suisse)  
Alice Quillen (University of Rochester, USA)  
Céline Reylé - *Chair* (Observatoire de Besançon, France)  
Annie Robin - *Co-chair* (Observatoire de Besançon, France)  
Mathias Schultheis - *Co-chair* (Observatoire de Besançon, France)  
Manuela Zoccali (Pontificia Universidad Catolica de Chile, Chili)

### ***Local Organising Committee:***

E. Burgey, C. Reylé, A. Robin, E. Soudagne, M. Schultheis (Besançon Observatory), L. Laffont (Le Grand-Bornand)

## **Scientific content:**

### ***Context:***

Exploiting large scale surveys, such as Gaia, PanStarrs, 2Mass, and many others, for enhancing our understanding of the formation of our Galaxy is a great challenge. It involves understanding of many different physical processes, including star formation, chemical evolution and dynamics. The understanding of this puzzle requires exchange between astrophysics experts in each of these physical aspects. Moreover the link between these different topics gives a better understanding on the formation and evolution of our Galaxy in order to obtain a better calibration tool for extragalactic systems.

The goal of this conference was to gather the astronomical community dealing with the Milky Way in order to exchange the newest scientific results and to address the key questions to solve the «puzzle of the Milky Way». Gaia will be launch in two years. It will provide an unprecedented map of the positions, kinematics and spectrophotometry of about a billion stars in the Milky Way and will give a new picture of our Galaxy. The community has to be prepared for the exploitation of such a large dataset well in advance. Thus another goal of the conference was to gather the international community in preparing the exploitation of the Gaia data.

### ***Conference scientific programme:***

The workshop was organised around three major issues:

#### 1 - Insight in early times

- First epochs assembly : halo assembly, streams, which time-scale?
- Thick disc formation : new observational constraints and alternative scenarios
- Inside Galaxy strubs or relics of first strubs : Stellar populations in the new Milky Way satellites
- Dark matter question : Milky Way meets lambda-CDM cosmology

#### 2 - Installation of the disc and dense regions

- Disc assembly: chemo-dynamical evolution, radial mixing
- Inner Galaxy: bulge/bar/inner disc interplay, role of mergers
- Disc non-axisymmetries: spiral, warp, bar. What structure, what dynamics ?
- How stars and Interstellar Medium interplay ? ISM large scale structure, stellar formation, gas infall, Galactic fountains,...

#### 3 - In place and up-coming tools for a better understanding

- Ongoing and upcoming surveys
- Galaxy modelling: stellar population models to dynamics

The detailed program is given at the end of the report.

The contributions were as follows: 29 invited contributions (30 minutes), 32 contributed talks (20 minutes) and 83 posters. Most of them are now available on the conference website.

Posters were visible during the whole conference in a large hall, close to the coffee break and lunch rooms. Dedicated sessions for poster viewing were also scheduled.

Invited speakers were: L. Athanassoula, T. Bensby, T. Beers, J. Binney, C. Brook, F. Bournaud, A. Brown, E. Churchwell, V. Debattista, J. Dickey, B. Famaey, A. Frebel, S. Kazantidis, K. Freeman, O. Gerhard, G. Gilmore, M. Haywood, A. Helmi, A. Koch, I. Minchev, J. Navarro, D. Pfenniger, J. Read, A. Robin, R. Schoedel, R. Schoenrich, M. Steinmetz, P. Tissera, M. Weinberg

### ***Venue:***

The conference was held in “L’Espace GdBo” in Le Grand Bornand, a typical village in the french Alps (<http://www.espacegrandbo.com/>). All participants were lodged in the village. Lunches were organized at the meeting place and were included in the registration fees. L’Espace GdBo also offered several places for discussion in small groups.

### ***Attendance and sponsoring:***

A total of 157 participants attended the workshop. Special care was taken to insure the accessibility of young researchers to the conference by sponsoring their expenses. In total, 25 students and postdocs received a financial support (fees and/or local expenses), as well as 12 invited speakers.

### ***Outreach:***

A public conference «Gaia ou la Voie Lactée en 3 dimensions» has been presented on Tuesday evening by Catherine Turon, astronomer in Paris Observatory. 60 persons attended the conference. An exposition «L’espace, comment ça marche ?» and a reduced model of the Gaia satellite were available for visit during the whole week.

### ***Proceedings:***

The proceedings of the conference will be published electronically by the European Physical Journal. Every document will have a Digital Object Identifier (an alphanumeric code to identify objects on the Internet) and can therefore be cited. This document might be a reference document concerning our knowledge of the Milky Way before Gaia launch.

### **Scientific outcome**

Although the programme was heavy with numerous invited and contributed talks, it still left times for participants to discuss.

One of these discussions was about the organisation of a workshop in the framework of GREAT research network. This workshop «Galaxy Modelling with a Gaia mock catalogue» will take place in February 2012 in Barcelona. It will gather theoretical Galaxy modelling researchers and Gaia data simulations providers to see how to use a Gaia mock catalogue for Galaxy modelling. The workshop will be a great opportunity for the Galaxy modelling community to appreciate the amount and complexity of the Gaia data and improve their theoretical model to be ready for the analysis of real Gaia data.

The conference was also an opportunity for young researchers to build new collaborations. We wish that some of them will be present at the time of the exploitation of incoming large surveys in the future (such as Gaia) and will have important role in the analysis and exploitation of the data that will draw a new picture of the Milky Way.

## Appendix: Final Program

### SUNDAY

18h-20h Registration and welcome drink

### MONDAY

8h45-9h Welcome

#### I- Insight in early times

#### Dark matter question : Milky Way meets lambda-CDM cosmology

*Chair R. de Propis*

9h -9h30 J. Navarro : review paper

9h30-10h00 P. Tissera : chemical evolution in hierarchical clustering scenarios

10h00-10h20 A. Font: Cosmological simulations of the formation of the stellar haloes around disc galaxies

10h20-10h40 M. Martig: Spiral galaxy formation in a cosmological context

*10h40-11h10 Coffee break*

*Chair S. Pasetto*

11h10-11h40 J. Read : dark side of the disc

11h40-12h00 A. McConnachie: Comparison to, and lessons from, Andromeda

12h00-12h20 F. Hammer: The Milky Way and other extragalactic systems

12h20-12h40 G. Stinson: Simulating the Milky Way in LCDM

*12h40-14h lunch*

#### First epochs assembly : halo assembly, streams, which timescale?

*Chair C. Turon*

14h-14h30 A. Helmi: Review paper on different aspects

14h30-15h00 T. Beers: The Assembly and Evolution of the Halo of the Milky Way as revealed by SDSS/SEGUE

15h00-15h20 B. Sesar: Mapping the Galactic Halo with Main-Sequence and RR Lyrae Stars

15h20-15h40 S. Jin: Dynamics of stellar and HI streams in the Milky Way halo

*15h40-16h10 Coffee break*

*Chair K. Vivas*

16h10-16h40 A. Frebel : review on first stars and extremely metal poor stars

16h40-17h00 L. Watkins: Substructure revealed by RR Lyraes in SDSS Stripe 82

*17h-18h Poster Session*

## 18h Welcome by the mayor of Le Grand Bornand and reception

### TUESDAY

*Chair K. Vivas*

9h00-9h20 M. Valluri: Using frequency maps of the stellar halo to construct the halo distribution function

9h20-9h40 P. Jofre-Pfeil: On the age determination of halo field stars

### **Inside Galaxy stubs or relics of first stubs : Stellar populations in the new Milky Way satellites**

*Chair M. Rejkuba*

9h40-10h10 G. Gilmore : Stellar populations in the Milky Way satellites

10h10-10h40 A. Koch : The puzzling assembly of the Milky Way halo : contributions from dsphs and GCs

*10h40-11h10 Coffee break*

11h10-11h30 J. Penarrubia: The Sagittarius stream and the Milky Way potential

11h30-11h50 S. Hidalgo: Star Formation History of the Isolated Dwarf Galaxies in the Local Group

11h50-12h10 M. Marks: The dynamical fingerprint of gas expulsion on the PDMF in GCs: Insights to the assembly of the Milky Ways' old GC system

### **Thick disc formation : new observational constraints and alternative scenarios**

*Chair A. Recio-Blanco*

12h10-12h40 F. Bournaud : Thick disc formation: new observational constraints and alternative scenarios

*12h40-14h00 Lunch*

14h00-14h30 T. Bensby : Chemical constraints on the formation of the galactic thick disc

14h30-14h50 J. Bird: Radial mixing in Galactic disks: The effects of disc structures and satellite bombardment

14h50-15h10 P. Di Matteo: Minor mergers and their impact on the characteristics of thick disks

15h10-15h30 G. Ruchti: Origins of the Thick Disk of the Galaxy as Traced by Metal-Poor Stars Selected from RAVE

*15h30-16h00 Coffee break*

### **II- Installation of the disc and dense regions**

#### **Disc assembly: chemo-dynamical evolution, radial mixing**

*Chair C. Reylé*

16h00-16h30 M. Haywood : Observational aspects of the radial mixing in the disc

16h30-16h50 T. Antoja: Kinematic groups across the MW disc: insights from models and from the RAVE catalogue

*17h-18h Poster Session*

20h30 Public Conference "Gaia ou la Voie Lactée à trois dimensions" by Catherine Turon, astronomer at Paris Observatory

## **WEDNESDAY**

*Chair F. Figueras*

- 9h-9h30 R. Schoenrich: theoretical aspects of the radial mixing  
9h30-9h50 R. Roskar: Implications of Radial Migration for Stellar Population Studies  
9h50-10h10 L. Casagrande: New constraints on the chemical evolution of the solar neighbourhood and Galactic disc(s)  
10h10-10h30 M. Smith: Kinematics of the Milky Way disc using SDSS

*10h30-11h Coffee break*

### **Inner Galaxy: bulge/bar/inner disc interplay, role of mergers**

*Chair C. Babusiaux*

- 11h-11h30 K. Freeman: observational aspects  
11h30-12h00 R. Schoedel: An observer's view of the central parsecs of the Milky Way  
12h00-12h20 V. Hill: Inner galactic disc metallicity distributions and the bulge-disc relation  
12h20-12h40 S. Feltzing: The chemical evolution of the Galactic Bulge seen through microlensing events  
12h40-13h00 M. Ness: The Formation of the Galactic Bulge of the Milky Way

*Free afternoon*

20h Conference dinner : repas savoyard, La Croix Saint Maurice

## **THURSDAY**

*Chair M. Schultheis*

- 9h-9h30 L. Athanassoula: Bar dynamics  
9h30-10h00 O. Gerhard: Bulge morphology and dark matter properties  
10h00-10h20 O. Gonzales: The bigger picture of the Galactic bulge  
10h20-10h40 I. Martinez-Valpuesta: Boxy bulge and planar "long bar" in the Milky Way

*10h40-11h10 Coffee break*

### **Disc non-axisymmetries: spiral, warp, bar. What structure, what dynamics ?**

*Chair D. Kawata*

- 11h10-11h40 B. Famaey : Detection of disk non-axisymmetries in local stellar kinematics  
11h40-12h10 I. Minchev: Modeling disk non-axisymmetries : implications for galactic evolution  
12h10-12h30 P. Patsis: Structures out of Chaos in barred-spiral systems

*12h30-14h lunch*

14h-14h20 E. D'onghia: Collective Origin of Spiral Structure in the Milky Way

**How stars and Interstellar Medium interplay ? ISM large scale structure, stellar formation, gas infall, Galactic fountains,...**

*Chair F. Fraternali*

14h20-14h50 J. Binney : How does the Galaxy accrete gas?

14h50-15h10 F. Combes: Molecular gas and star formation in the Milky Way

15h10-15h40 F. J. Lockman : How does the Milky Way continue to get its gas?

*15h40-16h10 Coffee break*

*Chair J. Green*

16h10-16h30 S. Sale: 3D Extinction Mapping Using Hierarchical Bayesian Models

16h30-17h00 E. Churchwell: properties of the MW at MIR Wavelengths

17h00-18h Poster Session

**FRIDAY**

**III- In place and up-coming tools for a better understanding  
Ongoing and upcoming surveys:**

*Chair P. Harding*

9h00-9h20 N. Martin: The Pan-STARRS view of the Milky Way

9h20-9h40 R. Benjamin: Glimpse 360: Mapping the Galaxy's Edge

9h40-10h10 M. Steinmetz: Spectroscopic Surveys in the Milky Way Disk and Halo

10h10-10h40 J. Dickey: Galactic and Magellanic Cloud Surveys of Cm-Wave Spectral Lines: two Steps Forward

*10h40-11h10 Coffee break*

*Chair X. Luri*

11h10-11h40 A. Brown: Astrometric surveys

**Galaxy modelling: stellar population models to dynamics**

11h40-12h10 A. Robin: Galaxy modelling through stellar population synthesis

12h10-12h40 V. Debattista: Modelling the Milky Way

*12h40-14h00 lunch*

*Chair H. Dejonghe*

14h00-14h30 C. Brook: chemo-dynamical modelling

14h30-14h50 S. Sharma: Galaxia: a code to generate a synthetic survey of the Milky Way

14h50-15h10 P. McMillan: Dynamical models of the Milky Way

15h10-15h50 DISCUSSION: D. Pfenniger: Assumption strengths and weaknesses in galaxy modelling

*15h50-16h20 Coffee break*

END OF THE CONFERENCE