GREAT-ITN and Gaia: Preparing for Science

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Why are we here?

Gaia + People = Science
The Promise of Gaia
Transformational Science

>20 globular clusters
Many thousands of Cepheids and RR Lyrae.

Mass of galaxy from rotation curve at 15 kpc
Sun
30 open clusters within 500 pc:

Horizon for detection of Jupiter mass planets (200 pc)

Proper motions in LMC/SMC individually to 2-3 km/s

General relativistic light-bending determined to 1 part in $10^5$

1 microarcsec/yr = 300 km/s at $z = 0.03$
(direct connection to inertial)

Horizon for proper motions accurate to 1 km/s

Dark matter in disc measured from distances/motions of K giants

Dynamics of disc, spiral arms, and bulge

Horizon for distances accurate to 10 per cent

1000 million objects measured to $l = 20$
Gaia ... from Camera Integration
Gaia ... from Telescope Integration

All ten mirrors successfully aligned

Image courtesy EADS-Astrium
Gaia ... to Launch

NGC 1818 in LMC
212x212 arcsec$^2$ (~1% of AF FoV)
2.85s integration time

launched 19 Dec 2013
Gaia ... to nominal operations

Gaia Nominal Scanning Law

The attitude of the satellite
GREAT: Gaia’s science community

- GREAT: Gaia Research for European Astronomy Training
  - Community network to increase knowledge and awareness of the science potential of Gaia
  - Increase the science impact of Gaia
  - GREAT ESF (networks) and GREAT ITN (training)
GREAT ESF RNP
Scientific Community Building

- Involves over 100 groups in over 20 countries
  - The ESF RNP is supported by 16 funding agencies
  - https://lists.cam.ac.uk/mailman/listinfo/ast-great-announce

- Key science remit inclusive across Gaia science
  - Origin, structure, evolution of the Milky Way
  - Stellar Astrophysics
  - Galactic Dynamics
  - Galactic Archaeology
  - Star formation and evolution
  - Fundamental physics
  - Extra solar planets
  - Solar system
  - The IT data challenge
GREAT Meetings
~1500 scientists attending ~40 events

http://great.ast.cam.ac.uk/Greatwiki/GaiaScienceMeetings
See this link also for the final reports from each meeting

Many papers, proceedings, white papers, proposals generated

- Gaia Data Access: requirements … CU9
- Instrumentation Initiatives … science case input to WEAVE and 4MOST
- Survey Initiatives … kick off community building workshops and conferences … Gaia-ESO Survey
- Science … white books and community workshops … Modelling, Gaia Alerts, Solar System, Spectral Analysis
GREAT-ESF networking e.g. in 2013

- GREAT-ITN/ GREAT-ESF School *Galactic dynamics, methods and techniques, in the times of Gaia and large scale surveys*. 3-12 November 2013, Mexico City (School website) (Meeting Final Report)

- GREAT-ESF Workshop *Extragalactic Science with Gaia*, 17-18 Oct 2013, Athens, Greece (Workshop website)

- GREAT-ESF School *EES2013 23rd Evry Schatzman School on Stellar Astrophysics Stellar ages*, 29 Sep - 4 Oct 2013, Roscoff, France (School website)

- GREAT-ITN/ GREAT-ESF Workshop *The World of Clusters*, 23-26 Sep 2013, Padua, Italy (Workshop website) (Meeting Final Report)

- GREAT-ITN/ GREAT-ESF School *The Galaxy, stellar compositions and dynamics*, 2-6 Sep 2013, Tenerife, Spain (School website) (Meeting Final Report)

- GREAT-ESF Workshop *Gaia Challenge*, 19-23 Aug 2013, University of Surrey, UK (workshop website) (Meeting Final Report)

- GREAT PLENARY *6th Great Plenary Meeting*, 10 - 12 Jul 2013, Turku, Finland (Plenary website) ((wiki site))
  - The GREAT Plenary will be taking place at the European Week of Astronomy, as Special Meeting 5 (10 Jul) and Symposium 11 (11-12 Jul 2013).

- GREAT-ESF Workshop *Fundamental Stellar Parameters - Special Session 3* @EWASS 2013, 8 Jul 2013, Turku, Finland (workshop website) (Meeting Final Report)

- GREAT-ITN/ GREAT-ESF School *GREAT Astro-statistics School*, 17-21 Jun 2013, Alicante, Spain (School website)

- GREAT-ESF Workshop *Asteroid Spectroscopy in Support of Gaia*, 6-7 Jun 2013, Nice, France (workshop website) (Meeting Final Report)

- GREAT-ESF CONFERENCE *First Results from the Gaia-ESO Survey*, 8-11 Apr 2013, OCA, Nice, France (conference website) (Meeting Final Report)
GREAT-ESF Meetings 2014

- **GREAT-ITN CONFERENCE**  *GREAT ITN Closing Conference: The Milky Way Unravelled by GREAT*, 1-5 December 2014, University of Barcelona, Spain

- **GREAT-ESF Workshop**  *Gaia Viz Workshop*, 9-11 July 2014, Vienna, Austria ([Workshop website](#))

- **GREAT-ESF Workshop**  *Solar System Science with Gaia*, 2-4 Jul 2014, Helsinki, Finland ([Meeting website](#)) (Note: organised as WS2 at ACM2014)

- **GREAT-ESF Workshop**  *Helios and Helium: what is wrong with them?*, 2-3 Jul 2014, Geneva, Switzerland ([Meeting website](#)) (Note: organised as Special Session 2 at the EWASS 2014 meeting).

- **GREAT PLENARY** 7th *Great Plenary Meeting*, 30 Jun - 2 Jul 2014, Geneva, Switzerland ([Plenary website](#)) ([wiki site](#))
  - The GREAT Plenary will be taking place at the [European Week of Astronomy](#), as Symposium 3 (30 Jun - 2 Jul 2014).

- **GREAT-ESF Workshop**  *Young Clusters in the Gaia-ESO Survey*, 20-22 May 2014, Palermo, Italy ([Workshop website](#))

- **GREAT-ESF Workshop**  *Gaia and the Unseen: The Brown Dwarf Question*, 24-26 March 2014, Torino, Italy ([Workshop website](#))

- **GREAT-ESF Workshop**  *Supernova from Gaia*, 5-7 Feb 2014, Queen's University Belfast, UK ([Workshop website](#))
Nearly all the GREAT-ITN students + plus some supervisors – meet them at this conference
The GREAT-ITN Institutes

Partners with students

Associate Partners

Industrial Partners
Training: The Science of Gaia
Leiden
Training: The Distance Scale
Teramo
Training: Visualisation
LSST@Seattle / Microsoft@Redmond
Gaia Live in School
2,200 pupils at 34 schools in 10 countries

Connecting schools across Europe to the wonder of space
http://great-itn.eu/gaialive
Gaia - The Billion Star Surveyor - charting the 3-D map of the Milky Way
25/03/2014

Credit: ESA
New Science from the GREAT-ITN preparing for Gaia

Some (randomly selected) previews of talks coming up in the conference ...
According to our model comparison, the model of extinction rate based on the solar motion is not favored by the mass extinction data. In addition, there is no periodicity in the mass extinction rate over the past 550 Myr.
Overview and stellar statistics of the expected *Gaia* Catalogue using the *Gaia* Object Generator

X. Luri\(^1\), M. Palmer\(^1\), F. Arenou\(^2\), E. Masana\(^1\), J. de Bruijne\(^3\), E. Antiche\(^1\), C. Babusiaux\(^2\), R. Borrachero\(^1\), P. Sartoretti\(^2\), F. Julbe\(^1\), Y. Isasi\(^1\), O. Martinez\(^1\), A. C. Robin\(^4\), C. Reylé\(^4\), C. Jordi\(^1\), and J. M. Carrasco\(^1\)

Fig. 1. Skymap of total integrated flux over the Milky Way, in the G band. The colour bar represents a relative scale, from maximum flux in white to minimum flux in black. The figure is plotted in Galactic coordinates with the Galactic-longitude orientation swapped left to right.
Radial migration of the Sun in the Milky Way: a statistical study

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Abstract

The determination of the Sun's radial migration allows us to understand the evolution of the stars in the Ophiuchus cluster. We used a dynamical model of the Milky Way to estimate the radial migration of the Sun. We found that the Sun's migration is consistent with the model of the Milky Way, and that the Sun has migrated from the inner regions of the Galaxy to the outer regions.

EXPLORING THE VARIABLE SKY WITH LINEAR. III. CLASSIFICATION OF PERIODIC LIGHT CURVES

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GS-TEC: the Gaia spectrophotometry transient events classifier

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Abstract

We present an algorithm for classifying the nearby transient objects detected by the Gaia satellite. The algorithm will use the low-resolution spectra from the blue and red spectrophotometers on board the satellite. Taking a Bayesian approach, we model the spectra using the newly constructed reference spectral library and literature-driven priors. We find that for magnitudes brighter than 19 in Gaia G magnitude, around 75 per cent of the transients will be robustly classified. The efficiency of the algorithm for Type Ia supernovae (SNe Ia) is higher than 80 per cent for magnitudes $G \leq 18$, dropping to approximately 60 per cent at magnitude $G = 19$. For SNe II, the efficiency varies from 75 to 60 per cent for $G \leq 18$, falling to 50 per cent at $G = 19$. The purity of our classifier is around 95 per cent for SNe I for all magnitudes. For SNe II, it is over 90 per cent for objects with $G \leq 19$. GS-TEC also estimates the redshifts with errors of $\sigma_z \approx 0.01$ and epochs with uncertainties $\sigma_t \approx \pm 13$ and 32 d for SNe I and SNe II, respectively. GS-TEC has been designed to be used on partially calibrated Gaia data. However, the concept could be extended to other kinds of low-resolution spectra classification for ongoing surveys.

GAIA DISCOVERS ITS FIRST SUPERNOVA

12 September 2014 While scanning the sky to measure the positions and movements of stars in our Galaxy, Gaia has discovered its first stellar explosion in another galaxy far, far away.

REAT-ITN @ Barcelona
The Milky Way Unravelled by Gaia: GREAT science from the Gaia Data Releases

ENJOY THE MEETING