Gaia Science Alerts Workshop 2010
Abstract Book

Abstracts of talks and posters at the Gaia Science Alerts Workshop, held at the Institute of Astronomy, Cambridge, June 23-25 2010.

Dr Giuseppe Altavilla, Bologna, Italy

Gaia & The Discovery of Supernovae - poster

This poster gives an overview of the discovery rate of supernovae (SNe) with time. Data about all SNe detected so far and about the expected Gaia SN detections are shown, focussing on type Ia SNe. The expected Gaia contribution to the discovery of new SNe is also compared with the expected performances of other surveys such as LSST, Pan-STARRS, SkyMapper and other projects. Finally, a few examples show how these SN detections, if coupled with a proper spectro-photometric follow-up, can contribute to the understanding of SNe.

Dr Martin Altmann, Heidelberg, Germany

Ground Based Optical Tracking of Gaia

The Ground based optical tracking (GBOT) project, required to ensure the precision of Gaia's orbit is another observing campaign to be conducted during the complete operational phase of Gaia. Precise knowledge of the satellite's orbit (both position and velocity vector) is mandatory in order to reach the scientific goals of the mission. One part of this effort is GBOT, which has the task to deliver astrometric measurements of Gaia on a daily basis, using a network of imagers on small (1-2 m) telescopes. The very nature of this undertaking implies similarities but also differences to the Science Alert program. In my contribution I will present GBOT and its status and also comment on its conceptual relation to the science alert follow up.

Dr Ross Burgon, Open University, UK

Alert distribution possibilities

In this presentation I will review the transmission and alert format possibilities for the Gaia Science Alerts Publishing (GSA-P) System and present a proposal for the transmission and format methods to be used.

Dr Simon Clark, Open University, UK

Variability, outbursts and mass loss amongst massive evolved stars

Massive stellar evolution is currently poorly understood due to the lack of observational constraints on the processes driving the significant mass loss that converts O stars to H-depleted Wolf Rayets

and subsequently, via SNe, to neutron stars and black holes. Nevertheless, evidence is accumulating that this proces may be mediated via violent, impulsive events. Over the course of its mission GAIA will provide an excellent tool to investigate such processes and I provide a review of developments in this field and potential links with with extreme type IIn SNe and other recently identified luminous transients.

Dr Martin Dominik, St.Andrews, UK

Microlensing live and in colour

Since the sensitivity of gravitational microlensing for the study of planets of Earth mass and below crucially depends on a prompt reaction to ongoing signals ("anomalies"), automated systems for event modelling, data visualisation, anomaly detection, and target selection have been developed. The ARTEMiS (Automated Robotic Terrestrial Exoplanet Microlensing Search) system has been designed to provide target recommendations for a non-proprietary heterogeneous network of telescopes based on a user-defined strategy, all currently available data, the individual telescope capabilities, and the observability. It not only provides tools to astronomers, but also brings forefront science to the general public with 'planet-hunting' becoming a live event. Efforts to extract statistical properties of planet populations from microlensing observations however suffer from the fact that properties of the majority of the probed host stars are poorly constrained. This could be overcome by a modest number of precise astrometric and space-based photometric measurements.

Dr Laurent Eyer, Geneva, Switzerland

Gaia and variable stars ; Ground based follow-up

In the understanding of the various variable phenomena in the Universe, the ESA Gaia mission is unique thanks to its comprehensive approach that combines ultra-precise astrometric measurements to nearly simultaneous spectro-photometric and spectrometric measurements. As any multi-epoch survey, it has specific properties related, for example, to its sampling law and to its types of measurements that will allow the identification and characterization of a large number of variable stars. We will present the strengths of the Gaia mission with respect to variable stars studies, the data processing that is envisioned within the DPAC consortium, as well as the ground-based follow up activities.

Dr Roger Ferlet, IAP, Paris, France

Hands-On Universe and outreach possibilities for Gaia Science Alerts

Dr Boris Gaensicke, Warwick, UK

The galactic population of cataclysmic variables.

I will give an overview of the properties cataclysmic variables. In particular, I will describe the recent progress that has been made towards a better understanding of the intrinsic galactic population of these binaries, predominantly thanks to SDSS, but with an increasing contribution of the

Catalina Real Time Transient Survey, coupled with intense follow-up by small-aperture telescopes. Finally, I will outline the scientific potential that GAIA transients have for driving forward the field of observational CV population studies, and how this will be to the benefit of our general understanding of compact binary evolution.

Dr Avishay Gal-Yam, Weizmann, Israel

The PTF core-collapse supernova key project

I will describe the goals of the PTF core-collapse key science project, and present our results to date. The PTF discovers ¿100 new core-collapse SNe per year, shortly (a few days) after explosion (by design), and at typical redshifts 0.01 - 0.1. A high fraction of these occur in dwarf galaxies, allowing to systematically probe the properties and explosions of massive low-metallcity stars. Our results show that dwarf galaxies host an anomalously high fraction of peculiar and even unique events, and that the statistics of normal events are also different from those seen in giant galaxies. It seems like our data suggest that massive star explosions are strongly affected by both lower metallicity as well as a second, unknown mechanism. I will highlight a few of the most unusual events.

Prof. Andy Gould, Ohio State University, US

Gaia Microlensing Alerts

To date, microlensing survey groups have detected over 5000 events, which has by themselves yielded tremendous scientific returns. However, a large fraction of the science extracted has been via intensive followup observations of a subset of these events. I briefly review this synergy and apply its lessons to prospective microlensing events from Gaia, taking particular account of the much wider field from which they are drawn and the much lower survey sampling rate.

Dr Rene Hudec, Ondrejov, Czech Republic

High-Energy Sources and Cataclysmic Variables as Alert Targets for Gaia. Major spectral changes from BP/RP.

1. I will discuss high-energy sources and cataclysmic variables as possible alert targets for the ESA Gaia mission, together will ground-based systems available (robotic telescopes and all sky camera) 2. I will review and discuss the possibilities to detect major spectral changes from Gaia RP/BP ultra-low dispersion spectroscopy.

Dr Agnes Kospal, Leiden, The Netherlands

Irregular variability during early stellar evolution: what can we learn about the circumstellar material?

As an introduction, I will briefly summarize variability statistics during pre-main sequence evolution. With special emphasis on the variability of low and intermediate mass stars, I will present

different variability patterns and their reasons. In the main part of my contribution I will focus on three specific variable types. All of them exhibit large flux changes and would benefit from an alert system. FUors are pre-main sequence stars showing rapid 5 mag brightenings at optical wavelengths that last for several decades. EXors show 1-5 mag brightenings lasting for a few months and repetitive on an irregular few years timescale. Both of these groups are thought to be low mass stars with unsteady accretion. The big eruptions are attributed to enhanced accretion from the circumstellar disk to the stellar surface. I will present example light curves for each group, and also for objects that seem to be intermediate between the two groups. I will discuss the importance of simultaneous multi-wavelength observations which could be triggered by a flux alert. As an example, I will present recent results from our successful monitoring campaign of the recent outburst of EX Lupi, the prototype of the EXor class. Next, I will focus on UXors, intermediate mass stars exhibiting irregular 1-5 mag deep "Algol-type" minima due to obscuration by dust clumps in an inhomogeneous circumstellar environment. I will present recent results from our spectral variability atlas of young stars and discuss how multi-wavelength, multi-epoch observations can put constraints on the circumstellar structure. Finally, I will conclude how Gaia can help to trigger coordinated monitoring campaigns of pre-main sequence variables.

Dr Andrew Levan, Warwick, UK

Orphan GRB afterglows with GAIA

Gamma-ray bursts are explosions of unrivalled brilliance, and are currently detected via their prompt, and extremely luminous gamma-ray emission. However, this emission is likely beamed, meaning that the "true" GRB rate could be a factor of several hundred larger than the observed rate. This means that many GRBs may be observed off-axis, and not exhibit a gamma-ray trigger, these events may be detectable by their optical afterglows, which will become visible as the jet expands (or if the optical emission is intrinsically less beamed than the gamma-rays) – so called orphan afterglows. The discovery of such events therefore offers a handle on the true GRB rate, and the beaming angle, and therefore is of importance not only in understanding GRBs themselves, but in their application as cosmological tools. Further, GAIA observations may potentially also uncover a population of underluminous, local events (which may dominate in numbers, but not in observed gamma-ray populations). I will discuss the prospects of detecting orphan afterglows with GAIA, and the science that their detection (or even non-detection) would enable.

Mr Fraser Lewis, Cardiff, UK

Follow-up opportunities with robotic telescopes

The 2metre Faulkes Telescopes, located in Hawaii and Australia, are research class telescopes which can be robotically controlled over the internet. In this talk I will discuss how these telescopes can be used to carry out rapid follow-up observations of GAIA alert objects.

Dr Ashish Mahabal, Caltech, US

Real-time Transient classification, follow-up and the way forward

For the last few years we have been using various surveys (e.g. Catalina Survey) to look for transients, classify them using a variety of methods (e.g. Bayesian Networks) and also carry out

follow-up observations in order to learn more about the objects as well as improve classification. Doing this in real-time and making the results public through alerts requires a non-standard setup. We will share our experiences and observations that can apply to other surveys like GAIA and also present the latest results.

Prof. Lech Mankiewicz, PAN Warsaw, Poland

Outreach/Citizen's Science potential of GAIA Science Alert System.

I will discuss possibilities for new Citizen's Science projects focused on follow-up observations for GAIA Science Alerts targets.

Dr Francois Mignard, OCA, Nice, France

The Gaia mission: a primer

In this introductory talk I will present the Gaia mission, intending primarily an audience from the scientific community not necessarily familiar with its goal and organisation. After a general introduction on the mission itself, objectives and expected performances, I will focus on the data acquisition system to show specifically how transient effects can be revealed and transmitted in the form of alerts to the astronomical community for follow up.

Professor Tim Naylor, Exeter, UK

The eSTAR Project

Prof. Paul O'Brien, University of Leicester, UK

High-energy transients

The transient high-energy sky is currently surveyed using a variety of experiments. I will discuss the current status of the Swift and MAXI missions and discuss future opportunities including SVOM and Janus. The advent of GAIA and similar optical surveys will provide a powerful incentive for the study of transients across the electromagnetic spectrum.

Dr Eran Ofek, Caltech, US

The Palomar Transient Factory

I will review the capabilities, status and discoveries of the Palomar transient Factory.

Prof. Don Pollacco, Belfast, UK

Real time followup of SuperWASP transients

We are currently constructing a 1m robotic telescope designed for rapid followup for transient sources discovered in the real time SuperWASP pipeline. First light for this facility will be summer 2010 and we expect full robotic operation within a year. The SuperWASP surveys monitor 500 square degrees of sky down to V=16 every 40 seconds and the data can be reduced and transients detected within a couple of minutes of exposure. In this poster i will detail the motivation for this facility and outline its capabilities.

Dr Dovi Poznanski, Berkeley, US

PTF - The reduction, subtraction, detection, and classification pipelines + some results

I will describe the chain of events from data acquisition to transient discovery and follow-up for the Palomar Transient Factory. My main focus will be on the candidate vetting (real or false) and classification (of what nature). Both are an order of magnitude more challenging than for previous surveys, due to the huge data volumes and wide scientific interests.

Dr Timo Prusti, ESA

Gaia mission status

A summary of the current status of Gaia is given with an emphasis on the scientific performance estimates.

Dr George Seabroke, UCL, UK

How Gaia's Radial Velocity Spectrometer (RVS) can contribute to Gaia Science Alerts

One of the planned (but yet to be implemented) primary outputs of processing RVS spectra (Ca II triplet: 847-874 nm) is science alerts for objects that require a rapid follow-up from the ground. A Single Transit Analysis (STA) will be executed daily on every object observed by RVS during the previous 24 hours. This will yield rest-frame calibrated spectra, radial and projected rotational velocities (and associated errors) and a check of whether objects are single or multiple. I will present an overview of this pipeline. As I will only have been working on RVS for ¡2 months, I hopefully will also present examples of daily STA spectra of possible flux alert objects (triggers and contaminants) as a function of magnitude to see if these will provide useful classification diagnostics (e.g. characteristic emission lines etc.). As flux and RVS alert detection systems will not necessarily trigger on the same objects, the relationship between the two should be discussed at this workshop.

Prof. Stephen Smartt, Queen's University Belfast, UK

Transient and Supernovae searches with PS1

Pan-STARRS1 is 1.8m telescope with a 7 sq degree field of view. It is carrying out sky surveys in several modes. The two major surveys are the 3Pi and Medium Deep Surveys. The PS1 Image Processing Pipeline has been designed to provide image subtraction within 24 hrs (goal of 35mins) of images being taken and cataloguing variable and transient sources. Queen's have built a classification pipeline which extracts the transient sources, verifies and matches them in timeseries, matches them to all other known catalogued sources and provides a probabilistic classification. I will show the latest results and how this could be applied to GAIA alerts.

Dr Danny Steeghs, Warwick, UK

Accretion-driven transients in the Galaxy

I will review the diverse populations of binary systems involving compact objects that will likely produce a wide range of transient phenomena. The cadence and coverage of GAIA will make it a very efficient resource for such systems. Key will be to identify the most promising events early and organise appropriate follow-up campaigns.

Prof. Iain Steele, Liverpool, UK

Transient Astronomy with the Liverpool Telescope: Software, Systems and Science

Liverpool Telescope (LT) has long had a key role in following up transient events on timescales ranging from days (e.g SNe) to minutes (e.g. GRBs). At the LT systems are now being set up to target responses to alerts from facilities such as LOFAR and ICECube. In the talk I will describe the technical and organizational challenges in building an effective transient response system. I will show how international standards developed both within astronomy and in the wider IT words can be exploited to develop robust, maintainable systems.

Dr Mark Sullivan, Oxford, UK

Gaia in the context of low-redshift transient surveys

I will discuss supernovae discovered by GAIA in the context of other ongoing low-redshift transient surveys, such as Palomar Transient Factory, PanStarrs-1 and SkyMapper.

Dr Paolo Tanga, Nice, France

Asteroid alerts.

The Solar System processing pipeline can deal with the discovery of new asteroids, that will trigger an alert. Also, asteroids could produce false photometric alerts on stars. I will deal with both

issues for bringing some elements into the discussion, as a complement to the presentation by F. Mignard.

Prof Nial Tanvir, Leicester, UK

GRB science with GAIA

Gamma-ray bursts are remarkably powerful explosions and offer a route to studying extreme relativistic physics, and also, thanks to their luminosities, probes of galaxy evolution and star formation throughout cosmic history. The wide field and automated real-time processing of GAIA may allow it to make important contributions to this field.

Dr Patrick Tisserand, Mount Stromlo Observatory, Australia

R Coronae Borealis variability and Galactic distribution

R Coronae Borealis stars (RCBs) is a rare type of evolved H-deficient and carbon-rich supergiant star ($M_V \sim 5$) that is increasingly thought to result from the merger of two white dwarfs (one CO- and one He-), called the Double Degenerate (DD) scenario. They show unpredictable fast declines in brightness, up to 9 magnitudes in the visible. These declines are the main signature of RCB type stars. I will present our actual knowledge on RCBs variability and their Galactic distribution.

Dr Massimo Turatto, Catania, Italy

Supernova monitor programs

I will present the ESO large Program on SNe carried out with telescopes in La Silla and other northern telescopes.

Dr Peter Wheatley, Warwick, UK

Optical transients detected by the Wide Angle Search for Planets (WASP)

I will describe the method used to identify optical transients in WASP and discuss the main results, with particular emphasis on dwarf novae.

Dr Przemek Wozniak, Los Alamos, US

Explosive Transient Detection in the Era of Synoptic Sky Surveys

The next generation of wide field time-domain surveys is positioned to revolutionize the study of astrophysical transients by linking heterogeneous surveys with a wide array of follow-up instruments as well as rapid dissemination of the transient events using a variety of mechanisms on the Internet. Searching a parameter space that spans many orders of magnitude in spatial coverage, time resolution, and sensitivity requires coordinated observations with instruments ranging from

robotic all sky monitors such as LANL's RAPTOR telescope network, to Peta-scale surveys of the future such as the Large Synoptic Survey Telescope (LSST). The main challenges ahead of massive time-domain surveys are timely recognition of interesting transients in the torrent of imaging data, and maximizing the utility of the follow-up observations. LSST alone is expected to deliver tens of thousands of variability alerts every night. Accurate event classification can be achieved by assimilating on the fly the required context information such as multi-color time-resolved photometry, galactic latitude, possible host galaxy information combined with broad-band spectral properties from external catalogs and alert feeds from other instruments. Here we describe transient detection systems developed for the RAPTOR project, discuss current trends, and outline future prospects for scaling into the LSST era.

Dr Lukasz Wyrzykowski and Dr Simon Hodgkin, IoA, UK

Gaia Science Alerts overview.

Mr Kamil Zloczewski and Dr Arkadiusz Olech, Warsaw, Poland

Dwarf novae in Gaia Alerts - poster.