Gaia: Switching ON the Transient Discovery Machine

The Milky Way Unravelled by Gaia - 5th December 2014

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I have $X^1$, why should I care about Gaia?

$^1 X = \text{your favourite transient survey}$

**Strengths:**
- Rates
- Nuclear transients

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*Image courtesy of B. Holl*

*Image courtesy of Gaia*

*Image courtesy of S. Koposov*

(Gets better later...)

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**3300-6800 A**
40 to 320 A pixel-1

**6400-10500 A**
70 to 150 A pixel-1

**PSF~0.05”**
I have Gaia, why should I care about Y?

1. \( Y = \) your favourite follow-up resources

Gaia: intelligent discovery
Follow-up: confirmation + characterisation
Gaia detection efficiency - transients

- Realistic mock galaxy catalogue (Baldry+2004). LF for blue + red galaxies.
- Sizes (Shen+2003).
- SN light curves (Li+2011)
- Simulation OnBoard detection and magnitude (GIBIS)
- Detection efficiency for different limiting magnitudes

GIBIS
Gaia Instrument and Basic Image Simulator
Galaxy-Transient detection

1 vs. 2 detected sources

Limiting magnitude G = 19

Detection efficiency vs. distance

Blagorodnova et al. (in prep)
Expected number of SNe. Limiting Magnitude=19

Altavilla et. al. 2012

Blagorodnova et. al. (in prep)

Belokurov, Evans 2003

Fig. 4

Fraction of the sky vs the expected end of mission number of transits. About 15.4% of the sky is expected to be observed 30-60 times, ∼56.6% of the sky is expected to be observed 60-90 times and ∼20.1% is expected to be observed 90-120 times. The remaining 7.9% is expected to be observed 120-240 times.

J. de Bruijne, private communication.

There are two types of inputs for this simulation: the transient properties (photometric evolution and rate of occurrence) and the survey strategy (survey area, limiting magnitude and monitoring cadence).

We considered “classical” SN classes: Ia, IIP, IIL, IIn and Ib/c. For each of these SN types we need to know: a) the template light and color curves along with absolute magnitude at maximum and dispersion (Li et al. 2011); b) the K-correction as a function of redshift from the template to the survey observing band (cf. Botticella et al. 2008); c) the current best estimate of the SN rate evolution with redshift (Botticella et al. 2008 and references therein).
Gaia Transient Classification

SN Ia templates from Hsiao et. al 2007
GSTEC-Gaia Spectrophotometry
Transient Event Classifier

\[ P(M \mid D, m_G, v) = \frac{P(D, m_G, v \mid M) P(M)}{\int P(D, m_G, v \mid M) P(M) dM} \]

Blagorodnova et. al. 2014
After the mission started...
First Gaia SN candidate

Re=3"
r=16.45
First Gaia SN!

Identification of the first Gaia SN as SN Ia at $z=0.03$!

Best fit model:
SN Ia, $2 \pm 8$ days, $z=0.03 \pm 0.01$

Confirmed from ground!
Summary

- Gaia and ground-based surveys are complementary
  - Gaia: intelligent discovery and astrometrical characterisation
  - Follow-up: photometric and spectral evolution

- Future
  - Understand the detection efficiency with mission data -> rates!
  - Follow-up and characterisation of nuclear transients -> new!

- The transient discovery machine has been switched **ON**…
Thank you!

DPAC
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