

Fast optical transients with Gaia

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CU5 (Hodgkin et al.)

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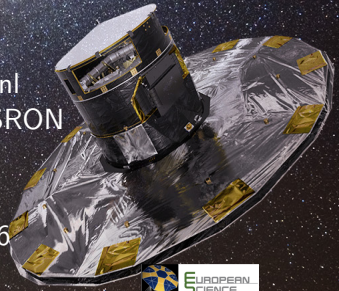
Radboud University, SRON

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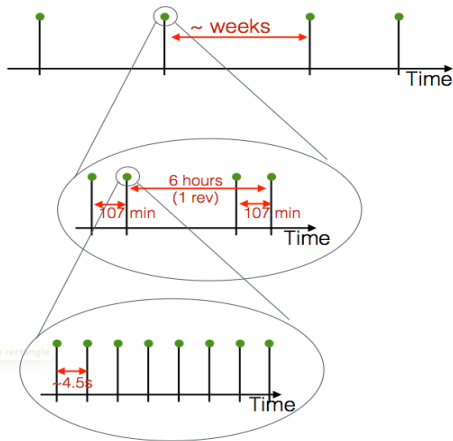
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SAMPLING OF LIGHT CURVE



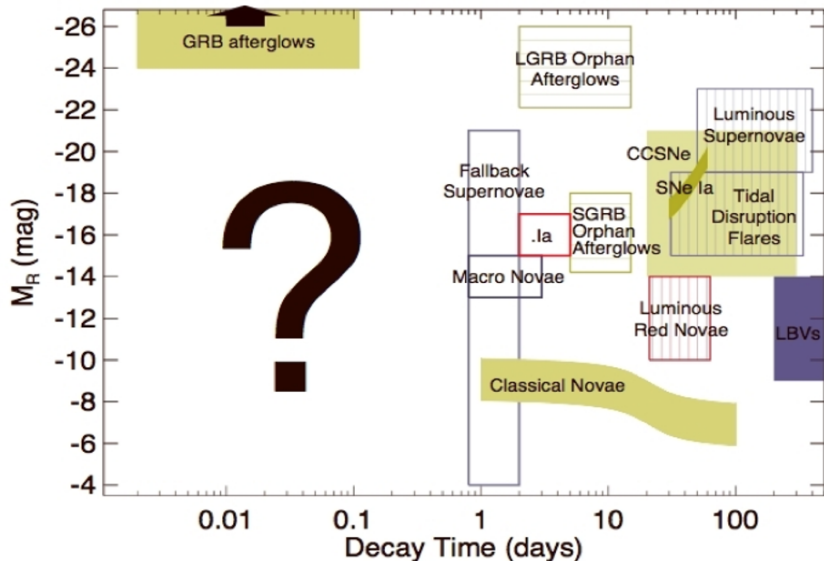
Each source observed many time in mission; sampling is predictable but uneven

Each visit, typically 2 transits in each of 2 fields of view: FoV transit $\rightarrow$ avg. mag

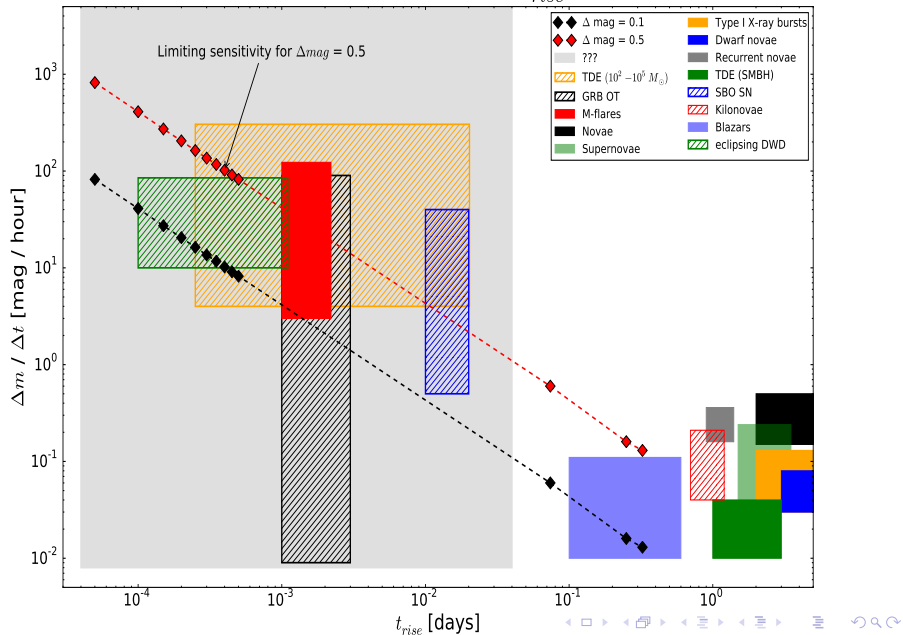
Each FoV includes up to 9 equivalent flux samples that can be averaged or used separately

Slide from Lukasz Wyrzykowski

'Classical' transient phase space (taken from LSST science book):



Rate of rise vs. t_{rise}



How to find transients in the Gaia data?

Use simple metrics to distinguish between transients, variables and garbage
Most promising so far:

- Skewness of the lightcurve
- von Neumann statistic

Fast and not CPU-intensive

Skewness? von Neumann statistic?

Skewness = third standardized moment of a time-series:
quantifies deviation from a Gaussian distribution

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von Neumann statistic: $\eta = \frac{\delta^2}{\sigma^2}$

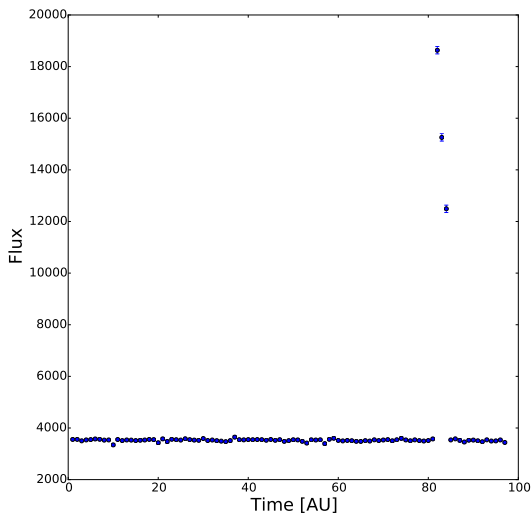
Ratio of the mean square pairwise difference to the variance

$$\text{where } \delta^2 = \frac{1}{n-1} \sum_{i=1}^{n-1} (x_{i+1} - x_i)^2$$

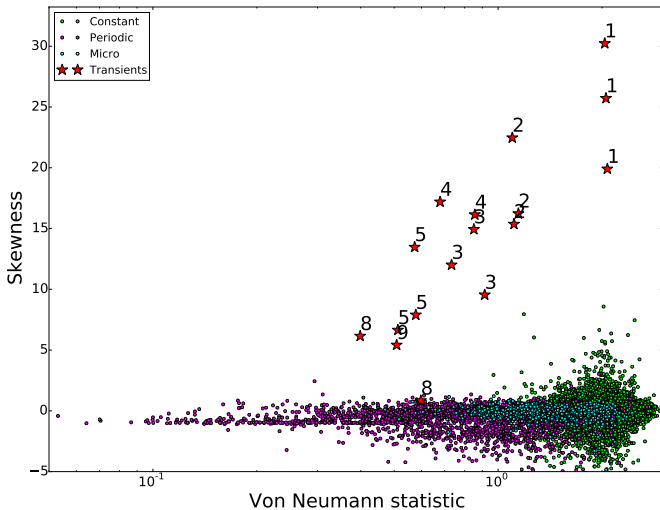
Example: application to Hipparcos data

- We add artificial transients to Hipparcos lightcurves
- Random time in the lightcurve
- Random flux increase (between factor 2 - 50 = 0.75 - 4 in mag)
- Exponential decay with random decay-time (1-9 datapoints)
- Try to recover these events

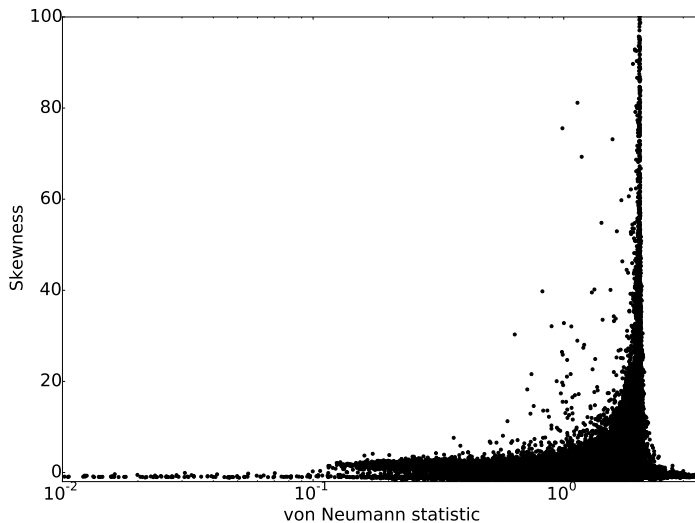
Example: application to Hipparcos data



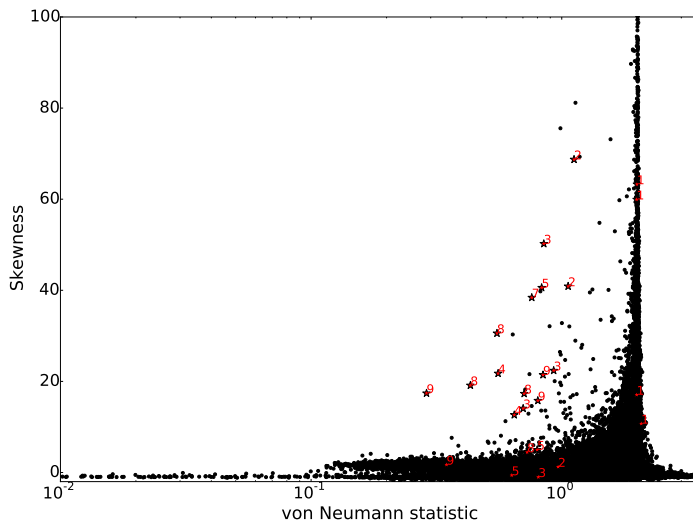
Example: application to Hipparcos data



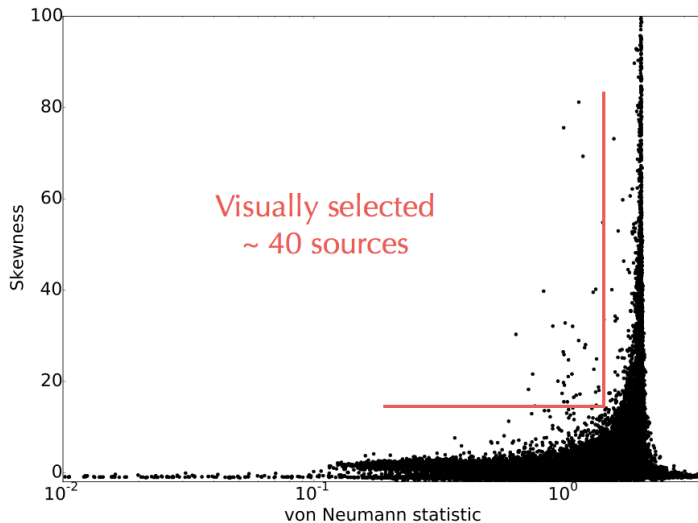
Application to Gaia data: level 5 healpixel (2893)



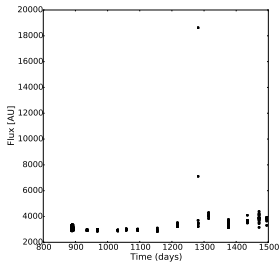
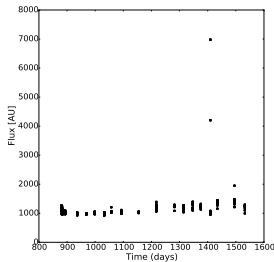
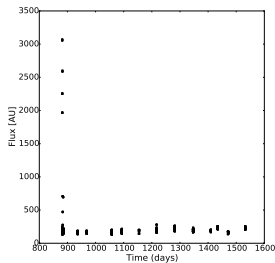
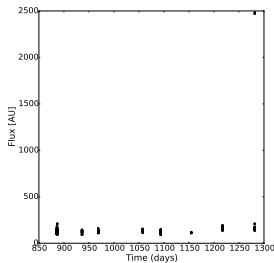
Application to Gaia data



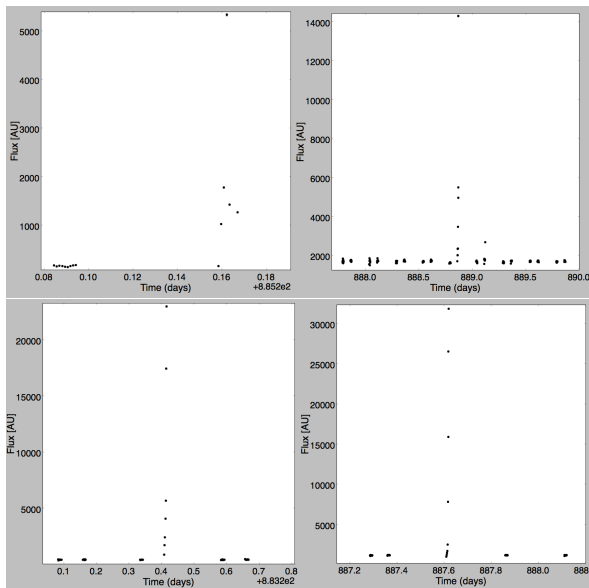
Application to Gaia data



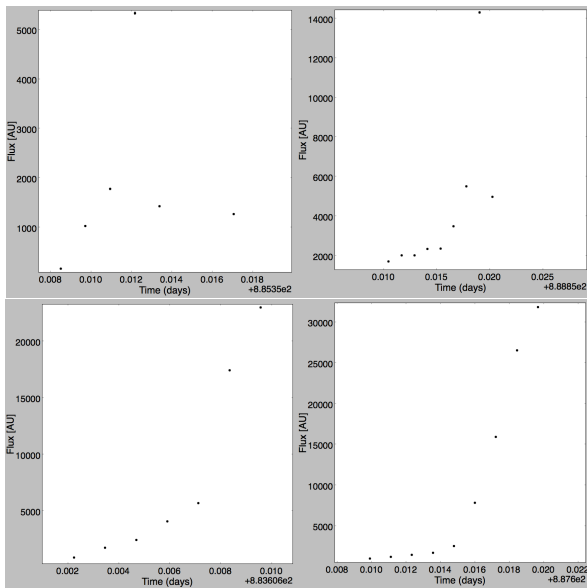
Application to Gaia data: some examples



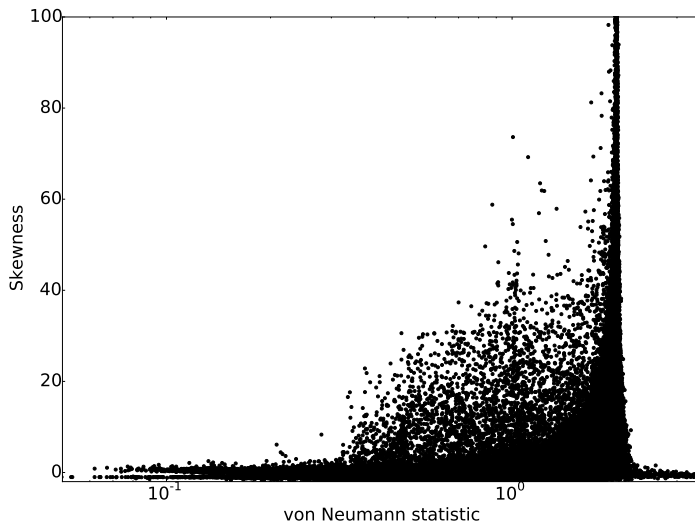
Application to Gaia data: some more examples



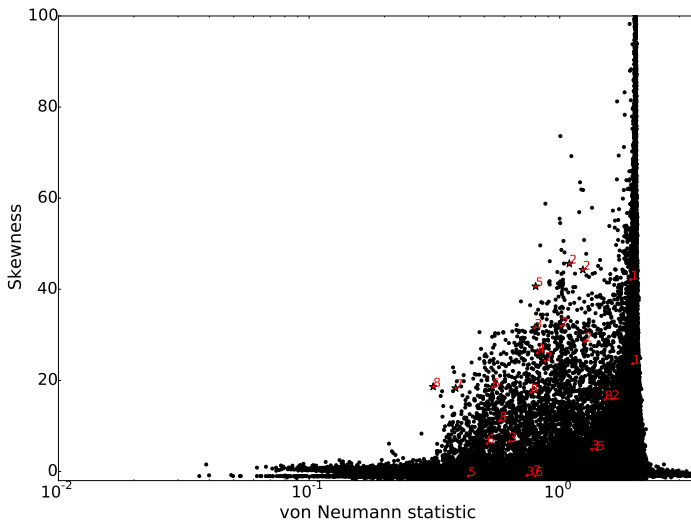
Application to Gaia data: some more examples



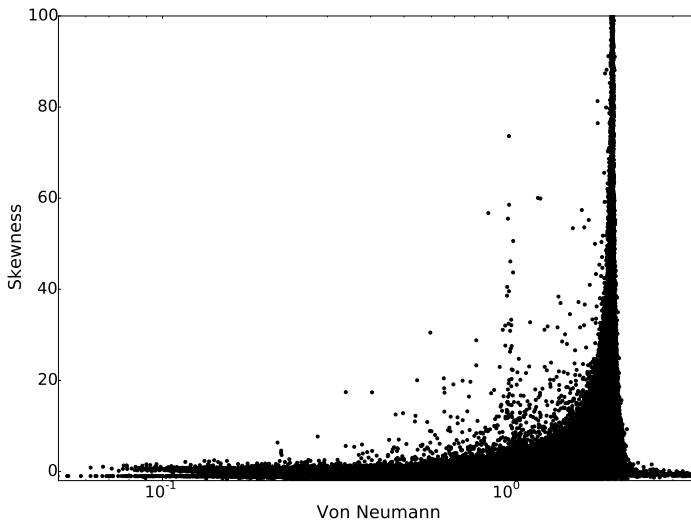
Application to Gaia data: another level 5 healpixel (859)



Application to Gaia data: another level 5 healpixel (859)



Application to Gaia data: another level 5 healpixel (859)



Future work

- Carefully select areas on the sky?
- Random forest classifier to replace visual selection boundaries
- Clustering analysis: time, sky position, amplitude, ...
- Use EPSL as test case (& training set?)