Science alerts for bright erupting Be Stars

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What are Be stars ?

Be stars are fast (generally not critically) rotating non-supergiant B-type stars showing or having shown once in their lifetime emission in their spectra. This emission generally occurs in the hydrogen Balmer line series, with decreasing intensity from Hα to the higher index lines, but it may also appear in other spectral lines such as the hydrogen Paschen lines (e.g. in the RVS wavelength range), Fe II or Mg II, as well as in the continuum. Emission is usually assumed to be formed in a surrounding equatorial disk. Since the analysis of the Hipparcos photometry (Gaia's predecessor !) done by Hubert & Floquet (1998, AA 335, 565), it becomes more and more obvious that the disk is formed during important mass ejection phases triggered by the combined effect of fast rotation and some additional, not yet well known, phenomenon which might be magnetic activity, non-radial pulsation beating, tidal forces due to a non detected companion, etc…

Why science alerts ?

Matter ejection is, at least for non critical rotating Be stars, the phenomenon that makes most of the Be stars appear as emission line stars. Being able to highlight with observational data the underlying physical processes that produce these outbursts would therefore shed a new light on the Be phenomenon and probably revolutionize our understanding of its origin. The best way to reach this level of knowledge is to construct semi-empirical dynamical models of these outbursts by simultaneously following the changes occurring the erupting event in the photosphere (mainly spectroscopic variations) and in the circumstellar environment (mainly photometric variations, but also spectroscopic). Establishing the link between spectroscopic and photometric variations, and obtain simultaneously photometry and spectroscopy for several Be stars during a complete erupting event would therefore be crucial. For practical reasons, this is unfortunately very difficult to achieve in the usual proposal/observation scheme. Even when labeled "periodic" the most usual outbursts are very difficult to accurately schedule well in advance and, therefore, to obtain observing time to follow the target simultaneously with photometric and spectroscopic observations is almost impossible.

Fortunately, there is a promising alternative. Instead of continuously following the spectroscopic and photometric time variations of several Be stars, one can also decide to observe spectroscopically those Be stars that showed, at a given moment, a certain photometric jump (larger than 0.12 mag in order to filter out most of the Be stars that only show rapid low amplitude photometric variations due to pulsation and to mainly consider a certain spectral type range around B2). In this framework, the Gaia

Science Alert network would be the ideal tool and provide us a very good opportunity to gather enough simultaneous spectroscopic and photometric data to achieve our goal.

How many alerts would this imply ?

The study made by Hubert & Floquet (1998) on Hipparcos data shows that most of the Be stars exhibitting magnitude variations larger than 0.12 mag have B0 to B2 spectral types, and that in this temperature range the fraction of Be stars to the total number of B type stars (with or without emission) is 0.33. On the other hand, according to the Gaia Universe Model Snapshot (GUMS) and the usual statistics on Be stars, 2000 O9 to B7 stars with G < 12 should be considered Be stars (GAIA-C5-TN-UB-BLM-001-1). We therefore expect that Gaia will be able to alert these outburst events in 300 to 600 bright (i.e. G < 12) Be stars.

How to select the alerts ?

To be selected the stars should have:

1. An effective temperature (See the GSP-Phot package in CU8) ranging from 10000 K to 30000 K (or equivalent colors indexes during the first processing cycles).
2. G < 12 in order to get at least one HR ground based spectrum with SNR > 100.
3. A magnitude jump in G ranging between 0.1 to 0.5 mags (i.e. for B-type stars, G and V magnitudes provide almost the same values).
4. If there are too much false detections we may also use the BPRP/RVS emission indexes provided by the CU8 ESP-ELS module. Since we are focusing on bright targets, the RVS will be available and, further, since the events we are tracking are mainly affecting early Be stars we expect a lot of line emission in this wavelength range.