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Dense stellar fields observed by the Blue and Red photometers of GAIA

A.M. Piersimoni[1], G. Busso[2], and P.M. Marrese[2]

[1] Istituto Nazionale di Astrofisica – Osservatorio Astronomico di Teramo, Via M. Maggini, I-64100 Teramo, Italy, e-mail: piersimoni@oa-teramo.inaf.it
[2] Leiden Observatory, P.O. Box 9513, 2300 RA Leiden, The Netherlands

Abstract. We present a summary of the problems related to the analysis of crowded fields observed by the blue and red photometers on board of the GAIA satellite and in particular an outline of the crowding evaluation.

Key words. Galaxy: formation, evolution – Astronomical data bases: Survey

1. Introduction

The main science goal of the GAIA Mission is the study of the formation and evolution of the Milky Way by means of a stereoscopic census with μas accuracy also delivering astrophysical parameters. To this aim the high density regions, like those with low extinction in the Galactic bulge represent a challenge for the ground-based reductions while being crucial for the Gaia science case. On board of Gaia, to achieve the photometry of the sources, there will be two slit-less spectrographs one of which operates in the blue (BP, 330-680 nm) and the other in the red (RP, 640-1050 nm). The raw data will consist of windows (60×12 or 60×1 pixels depending on the magnitude) containing dispersed images of each source.

2. The contamination issue

Gaia design makes images from the two telescopes overlap, increasing the probability that a star will be crowded from nearby objects. A first estimate of the fraction of BP/RP transits that will be strongly crowded into the focal plane, taking into account the overlapping of the two fields of view, has been evaluated by Marrese & Busso (2007). In this work the expected frequency of the deblending procedure for the whole mission lifetime has been estimated of the order of 10%. In order to assess the contamination issue we have to face with different problems: a) the real size of the spectra both in the along scan with magnitude and colour of the source and are different in BP and RP, and b) the contamination from stars that are too faint to have assigned a window and for which we will miss any relevant information at least in the early stages of the mission.

2.1. The crowding evaluation

The crowding evaluation algorithm will determine for each window if it is isolated, and if it isn't will provide a list of the disturbing sources.

Send offprint requests to: A. Piersimoni

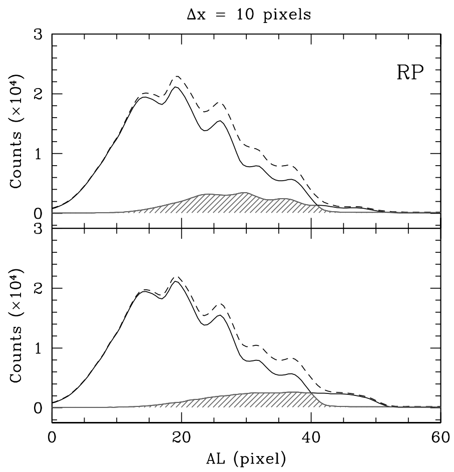

Fig. 1. The RP templates spectra computed for two stars with $[Fe/H] = 0$ and $\log g = 4.5$ are plotted; the fainter is shifted in the AL direction of 10 pixels. The primary star has $G_{RP} = 12$ *mag* and $(V - I) = 2.26$ *mag* that is $T_{\rm eff}$= 3500 K. The secondary star has in the upper panel the same colour of the primary one while in the lower panel its colour is $(V - I) = 0.0$ *mag*, $T_{\rm eff}$= 9500 K, its magnitude is in both cases $G_{RP} = 14$ *mag*. The combined flux of the two templates is indicated by the dashed line. The shadowed regions represent the contaminated part of the fainter star.

It is becoming clear that a rigorous assessment of the crowding would require a prediction of each dispersed image in the focal plane, that is a 2D simulation of the BP/RP data; however this is a very time-consuming task. So to determine a criterion suitable for a first order estimate of the contamination we made several experiments by adopting the simulated data by GIBIS 3.2 (Babusiaux et al. 2007). We derived a number of template spectra, with different astrophysical parameters, from where we computed the size of the spectra as a function of the V magnitude for different colours both in AL and in AC[1]. Moreover we obtained the percentage of the contaminated flux as a function of magnitude, colour and distance of two objects. In fact an isolated source is a source for which the contribution from the neighbours are below a certain level. We verified that after relative positions and magnitude differences, both of which are available input data for our processing, the most important parameter that influences the contaminated flux is the colour of the targets. In Fig. 1 we show for RP the individual and summed fluxes vs the AL dimension of a couple of sources placed at a distance of 10 pixels in AL. The brighter star has in both panels $G_{RP} = 12$ *mag* and $(V - I) = 2.26$ while the secondary star, with $G_{RP} = 14$ *mag* has in the upper panel $(V - I) = 2.26$ and in the lower one $(V - I) = 0.0$. It is important to notice that the percentage of the contaminated flux for the secondary star is larger for the redder one and this difference amounts to about 15%. An optimal flux extraction in case of overlapping images is closely related to the correct assignment of the astrophysical parameters to the sources. For this reason both the crowding evaluation and the deblending procedure will be repeated periodically in order to take the latest information on sources into account. However since most of these parameters will be unknown in the early phases of the mission we will have to select 'shape parameters'well related, for instance, to the temperature that largely dominates the morphology of the spectra.

Further experiments are in progress to explore the most efficient temperature indicators and to refine the crowding evaluation algorithm to be implemented into the photometric reduction pipeline.

References

Babusiaux,C., et al. 2007, GAIA-C2-SP-OPM-CB-003

Marrese, P. M. & Busso,G., 2007 GAIA-C5-TN-LEI-PM-003-1

[1] The limits of the spectra were considered the pixels where the star flux is at the sky level (the nominal value is 22.5mag/$arcsec^2$) ± 3σ.