What Gaia will see

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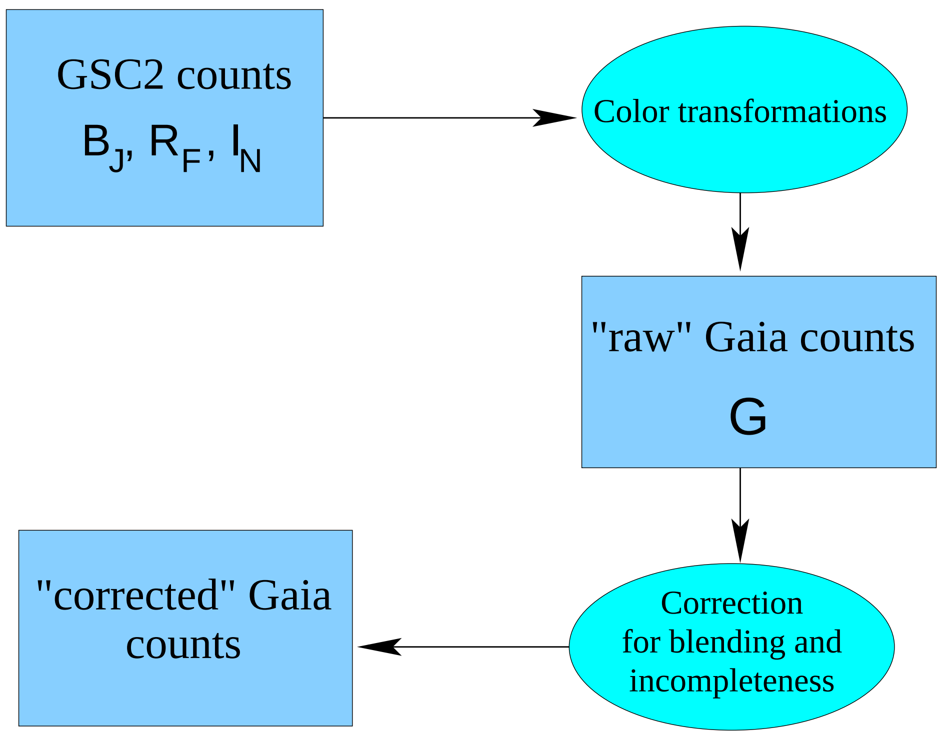
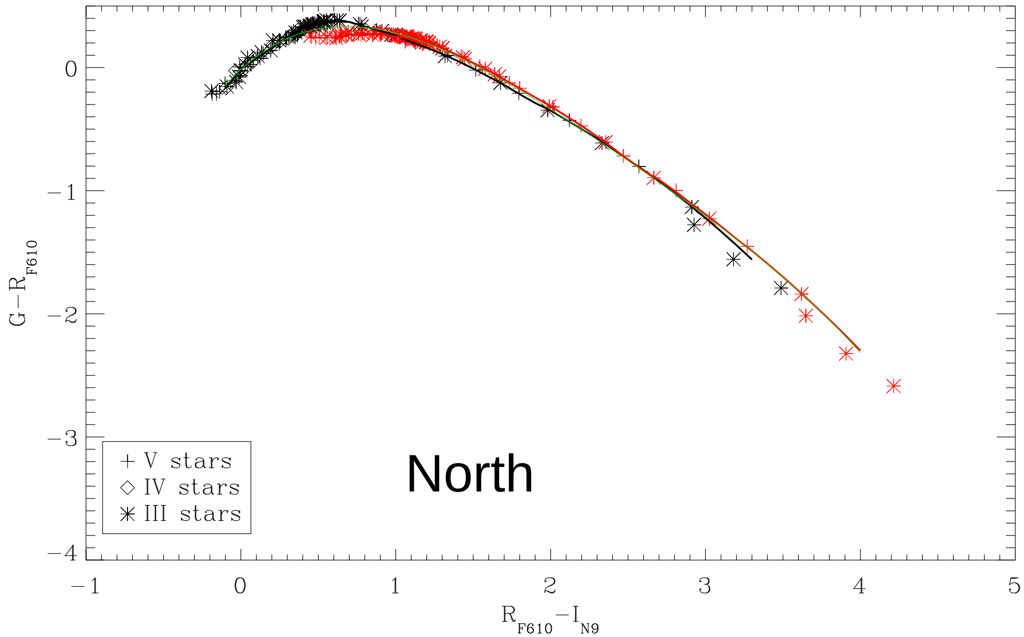
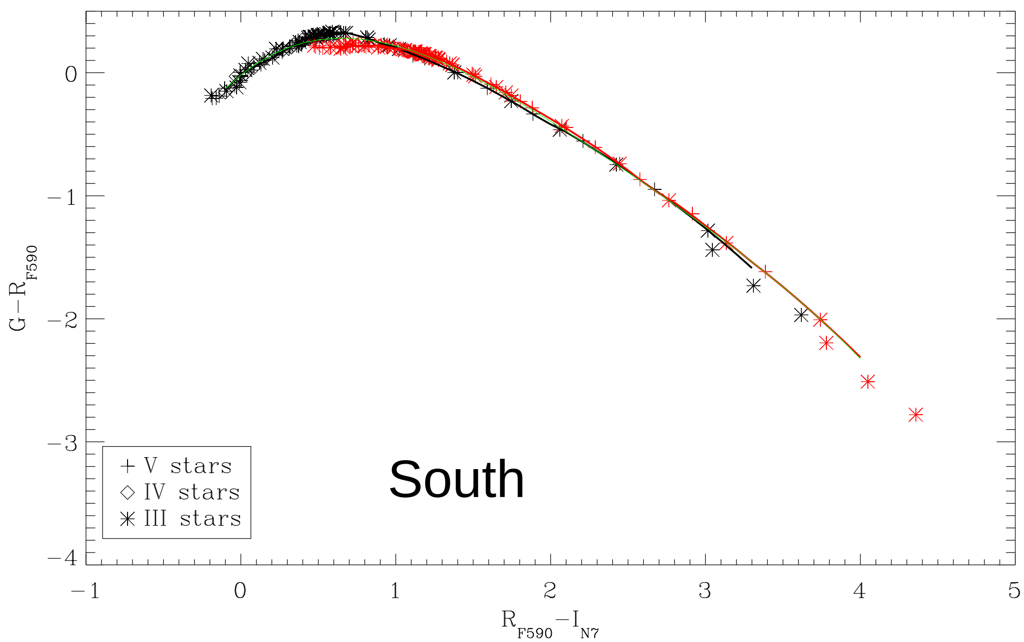


The GSC2.3 (Guide Star Catalogue 2.3) is used to estimate the number of stars, as a function of magnitude and position, that will be observed by the ESA Cornerstone Mission, Gaia.

(For a discription of GSC2.3, see poster JD13-49.)

Color transformations

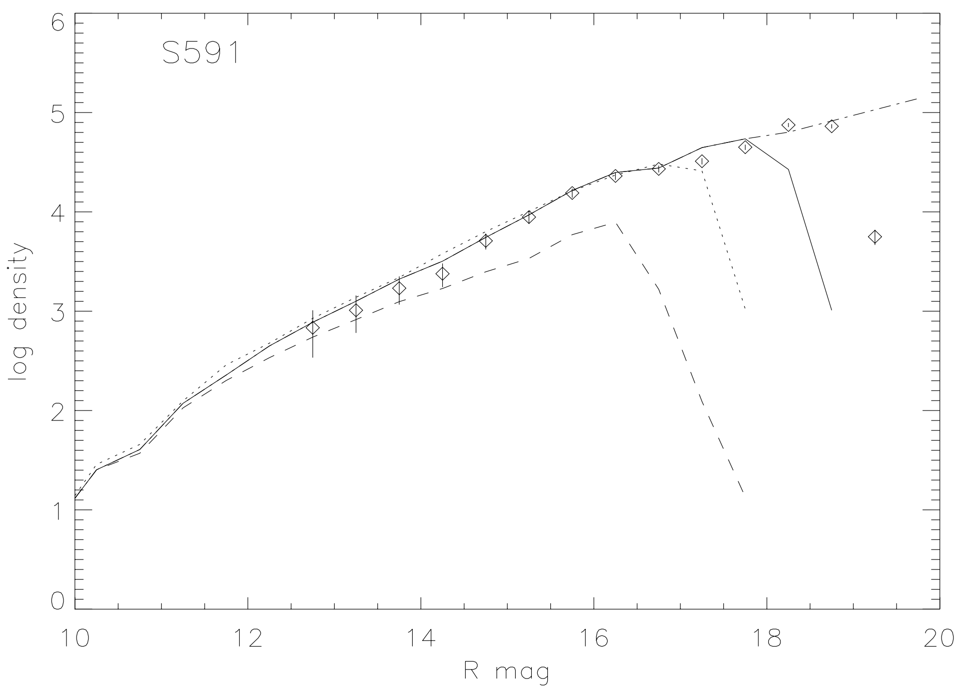




- The Gaia unfiltered G band magnitude of each GSC2 object is found using primarily the GSC2 R-I color transformation, since it is nearly independent of the reddening.

Plots show the color transformations based on the synthetic photometry for the northern and southern hemispheres. Black symbols are stars with no extinction, red symbols with Av = 3mag. The green curve is a quadratic polynomial fit to all points.

Star counts are compiled for approximately 1 sq. degree regions covering the whole sky. However, these must be corrected at low Galactic latitudes where image crowding causes blending and consequent misclassification.

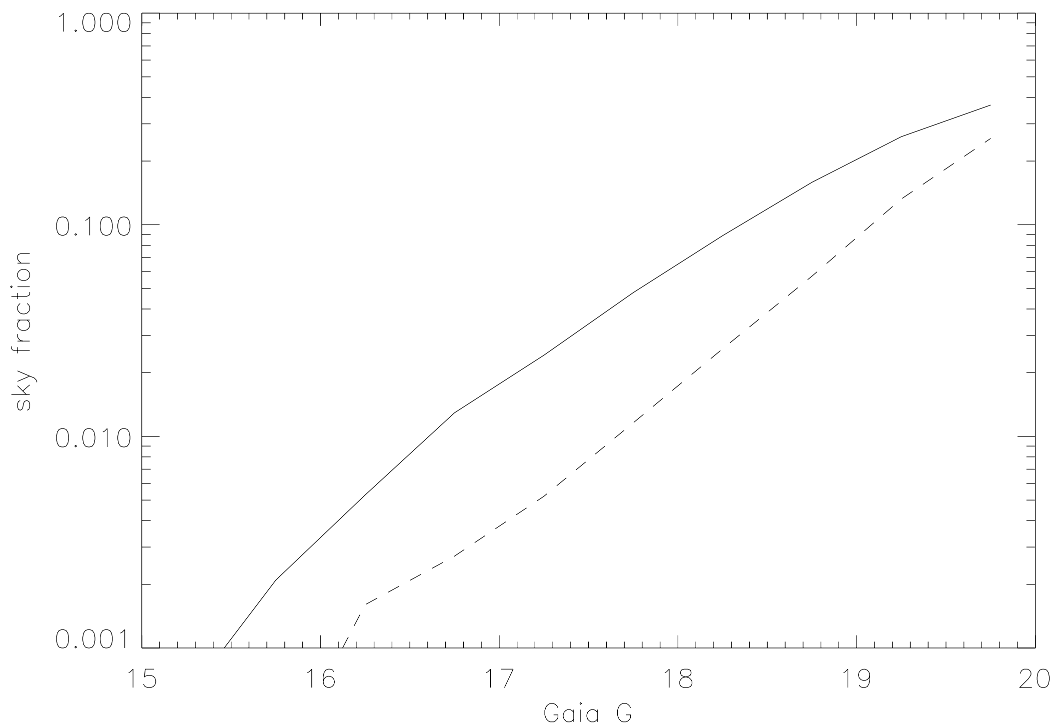


Field density (# per sq. degree): GSC2 raw star counts (dashed line); GSC2 total object counts (dotted line); counts corrected for blending (solid line) and counts extrapolated past completeness limit (dash-dot line). Diamonds show the stellar density from CCD data (from the Guide Star *Photometric* Catalogue).

A simple, but robust, procedure is used to correct the region counts:

1. An unreddened galaxy magnitude distribution (GMD) is adopted based on GSC2 “nonstar” counts at the NGP.
2. For each region, a reddened GMD is found using a Galactic extinction model.
3. The overcount of nonstars are assumed to be blended stars, which in turn are assumed to be composed of two stars of equal magnitude.
4. If the corrected counts suffer from incompleteness at faint magnitudes, extrapolated counts are used to correct for incompleteness.

The figure to the right shows the GSC2 counts corrected for a crowded region suffering strongly from blending, and validated against high-resolution CCD data.

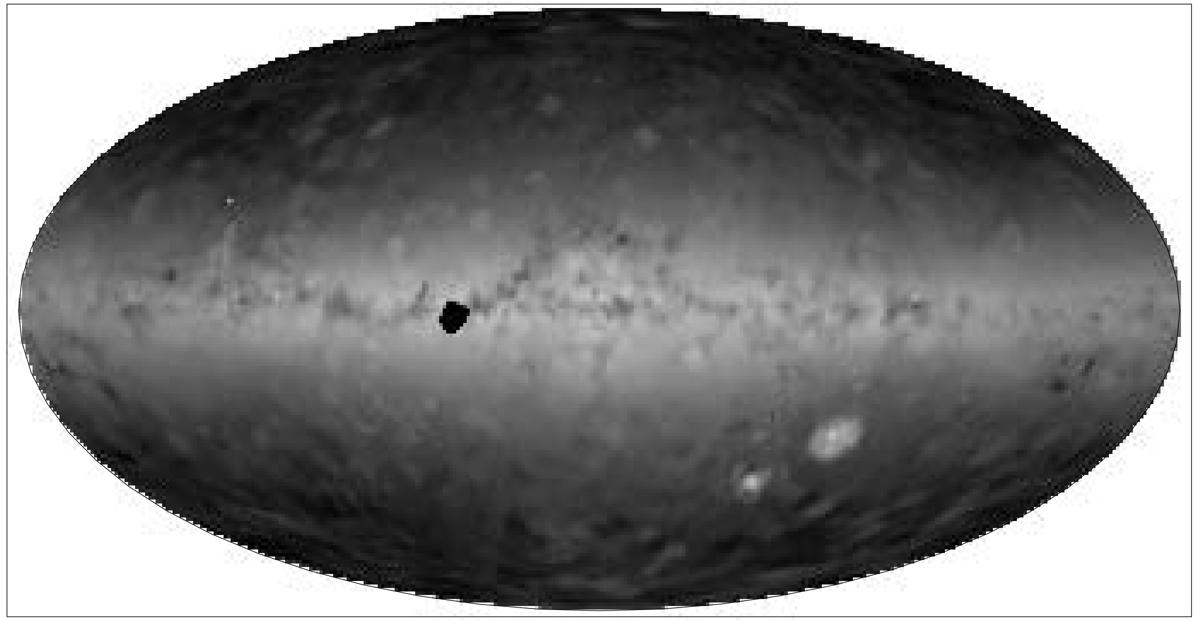


The completeness limit of each region is estimated, before and after effecting the correction for blending, assuming that for any realistic magnitude distribution the number of objects increases monotonically with magnitude. This plot shows the fraction of sky that is incomplete with as a function of limiting magnitude before (solid line) and after (dashed line) correcting for blending. For example, about 7% of the sky is incomplete at magnitude 18 before correcting for blending, but only 2% remains incomplete at 18th magnitude after correcting for blending.

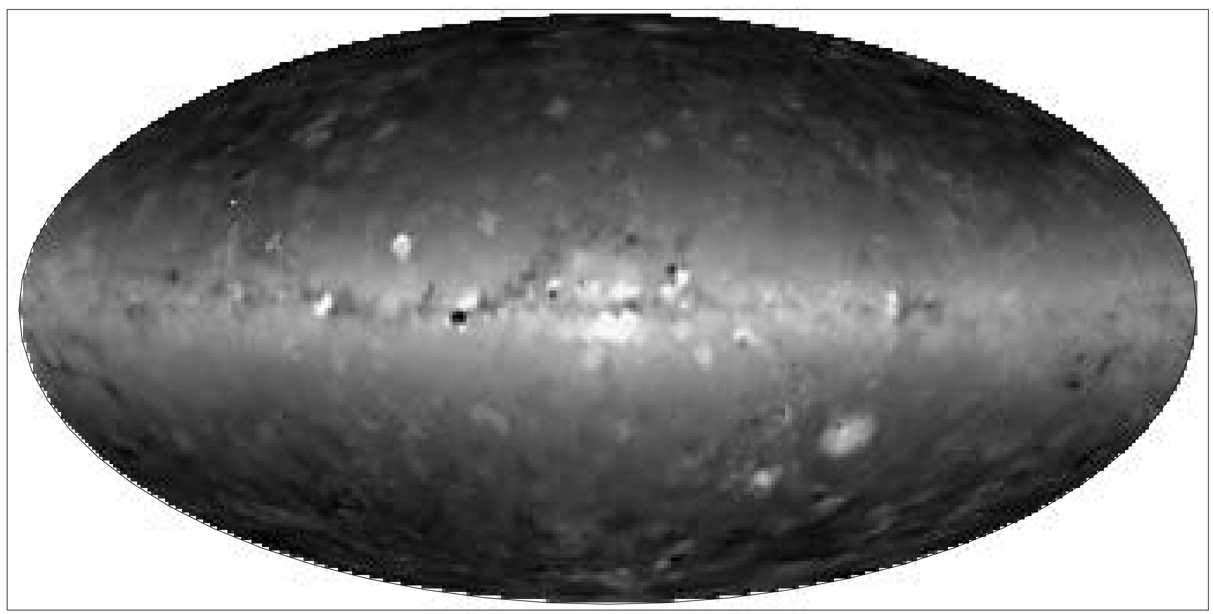
Images to the left show the stellar field density over the whole sky on a logarithmic grey scale from 10^3 to 10^6 stars per sq. degree, to the limiting magnitude of G=20, before and after corrections are applied. The Galactic bulge is much more evident after the corrections.

(Black area in upper plot is due to missing data.)

Before:



After:



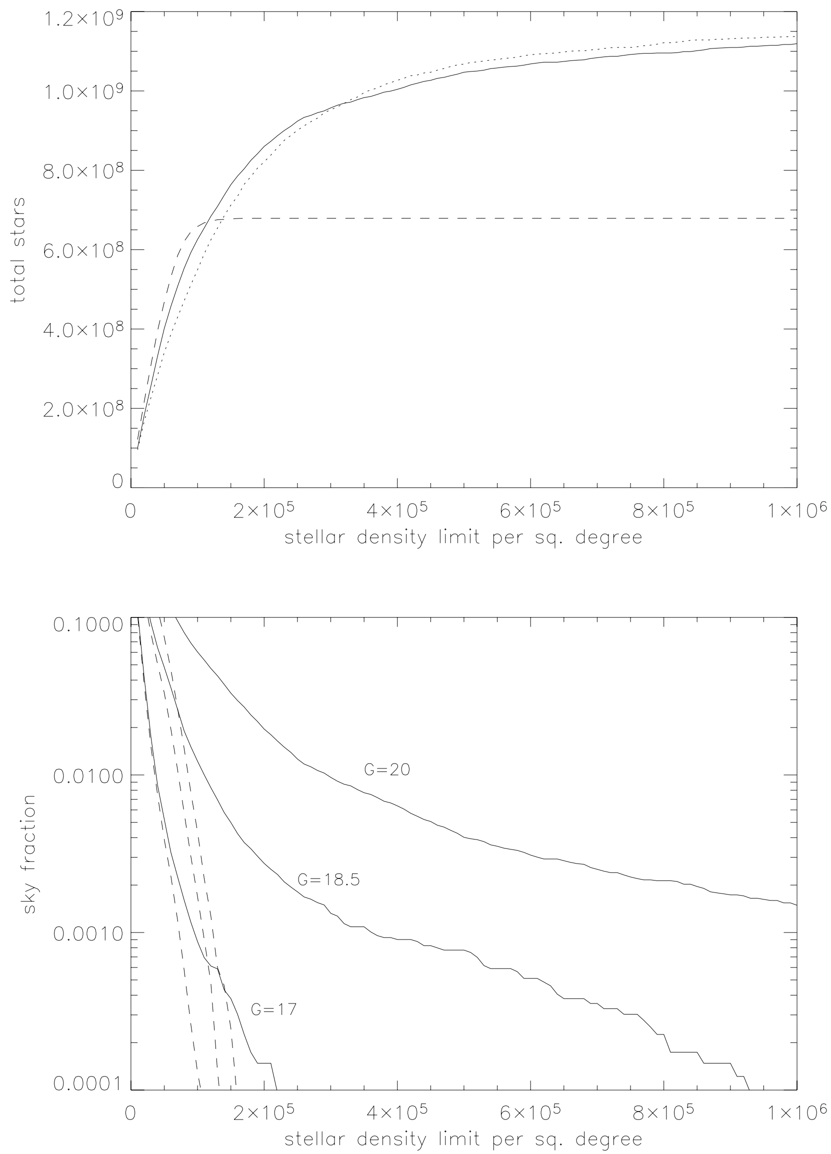
All-sky accumulated star counts

Gaia G magnitude	GSC2 (raw)	GSC2 (corrected)	Besançon model
13	5.32e+06	6.10e+06	7.59e+06
14	1.44e+07	1.74e+07	1.99e+07
15	3.09e+07	4.11e+07	4.52e+07
16	5.92e+07	8.99e+07	9.51e+07
17	1.01e+08	1.83e+08	1.88e+08
18	1.45e+08	3.50e+08	3.55e+08
19	1.74e+08	6.72e+08	6.52e+08
20	1.88e+08	1.32e+09	1.17e+09

While only a relatively small fraction of the sky suffers from blending, it is the part which has the most stars. Hence the corrections for blending and incompleteness results in a significant increase in the total number of stars. As this table shows, the resulting accumulated counts agrees fairly well with the Besançon Galaxy model, used for simulating the Gaia data stream. Indeed, the GSC2 counts have been used as a first all-sky check of the Besançon model.

We expect Gaia to observe approximately 1.3 billion stars.

All-sky statistics



A sample of all-sky statistics are shown here. The upper figure shows the accumulated sum of stars as a function of limiting stellar field density, while the lower shows the fraction of sky exceeding a given limiting stellar field density, both before (dashed line) and after (solid line) correction. The upper also shows the accumulated sum of the Besançon Galaxy model (dotted line). Given detector or on-board processing limits, the lower statistic shows what fraction of the sky will exceed the stated limit.