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## Erratum: Gaia Early Data Release 3

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O. Creevey, D. Evans, L. Eyer, A. Hutton, et al.

► **To cite this version:**

A. Brown, A. Vallenari, T. Prusti, J. de Bruijne, C. Babusiaux, et al.. Erratum: Gaia Early Data Release 3. *Astronomy and Astrophysics - A&A*, 2021, 650, pp.C3. 10.1051/0004-6361/202039657e . hal-03385137

**HAL Id: hal-03385137**

**<https://hal.science/hal-03385137>**

Submitted on 16 Nov 2021

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## Gaia Early Data Release 3

### Summary of the contents and survey properties

#### (Corrigendum)

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(Affiliations can be found after the references)

A&A, 649, A1 (2021), <https://doi.org/10.1051/0004-6361/202039657>

**Key words.** catalogs – astrometry – parallaxes – proper motions – techniques: photometric – errata, addenda

This is a corrigendum for [Gaia Collaboration \(2021\)](#). It corrects errors in Sects. 6.3.2 and 7.2 and Appendix A, which erroneously state that the correction to the *G*-band fluxes and magnitudes presented in [Riello et al. \(2021\)](#) (their Table 5) should be applied to sources in *Gaia* EDR3 with six-parameter astrometric solutions. In fact, the corrections should be applied to sources with two-parameter or six-parameter astrometric solutions. The corrected Astronomical Data Query Language (ADQL) query and Python source code from Appendix A are presented in the new version of Appendix A below.

Following the discovery of the above error, a more detailed investigation was done for the sources with two-parameter (2-p) astrometric solutions. Out of the 344 million 2-p sources present in *Gaia* EDR3, about 20 million have an astrometric solution in which the actual source colour was used instead of a default colour. This means that for these 20 million 2-p sources the *G*-band correction should actually not be applied. These sources are mostly faint, with 96% at magnitudes  $G > 20$ , and for 75% of these 20 million sources the correction that is (wrongly) applied amounts to less than 4 milli-magnitudes. It was thus decided

not to make a special effort to exclude these sources from the correction. Should a user of the *Gaia* EDR3 data wish to undo the wrong correction for one or more of these 20 million sources, the list of source IDs and applied corrections can be provided on request.

## Appendix A: *G*-band corrections for sources with two-parameter or six-parameter astrometric solutions

Figure A.1 shows how to formulate an ADQL query, to be executed in the *Gaia* EDR3 archive, that contains an on-the-fly calculation of the corrected *G*-band fluxes or magnitudes. These queries are somewhat complex and create a performance overhead. Hence downloading the requisite *Gaia* EDR3 fields and calculating the corrections a posteriori may be more efficient. Example Python code to do this is included in Fig. A.2. The Python code is also available as a Jupyter notebook<sup>1</sup>.

<sup>1</sup> <https://github.com/agabrown/gaiaedr3-6p-gband-correction>

Query that includes a calculation of the *G*-band flux correction. The condition ‘bp\_rp > -20’ ensures that no correction is attempted in case the ( $G_{BP} - G_{RP}$ ) colour is not available (‘bp\_rp is not null’ does not work). The condition on random\_index is included to retrieve example data for a random sample of sources.

```
select source_id, astrometric_params_solved, bp_rp, phot_g_mean_mag, phot_g_mean_flux,
if_then_else(
  bp_rp > -20,
  case_condition(
    phot_g_mean_flux * (1.00525 -0.02323*greatest(0.25, least(bp_rp, 3))
      +0.01740*power(greatest(0.25, least(bp_rp, 3)),2)
      -0.00253*power(greatest(0.25, least(bp_rp, 3)),3)),
    astrometric_params_solved = 31,
    phot_g_mean_flux,
    phot_g_mean_mag < 13,
    phot_g_mean_flux,
    phot_g_mean_mag < 16,
    phot_g_mean_flux * (1.00876 -0.02540*greatest(0.25, least(bp_rp, 3))
      +0.01747*power(greatest(0.25, least(bp_rp, 3)),2)
      -0.00277*power(greatest(0.25, least(bp_rp, 3)),3))
  ),
  phot_g_mean_flux
) as phot_g_mean_flux_corr
from gaiaedr3.gaia_source
where random_index between 1000000 and 1999999
```

Query that includes a calculation of the *G*-band magnitude correction. We note the type-cast ‘to\_real()’ of the return value of the conditional part of the query.

```
select source_id, astrometric_params_solved, bp_rp, phot_g_mean_mag, phot_g_mean_flux,
if_then_else(
  bp_rp > -20,
  to_real(case_condition(
    phot_g_mean_mag - 2.5*log10( (1.00525 -0.02323*greatest(0.25, least(bp_rp, 3))
      +0.01740*power(greatest(0.25, least(bp_rp, 3)),2)
      -0.00253*power(greatest(0.25, least(bp_rp, 3)),3)) ),
    astrometric_params_solved = 31,
    phot_g_mean_mag,
    phot_g_mean_mag < 13,
    phot_g_mean_mag,
    phot_g_mean_mag < 16,
    phot_g_mean_mag - 2.5*log10( (1.00876 -0.02540*greatest(0.25, least(bp_rp, 3))
      +0.01747*power(greatest(0.25, least(bp_rp, 3)),2)
      -0.00277*power(greatest(0.25, least(bp_rp, 3)),3)) )
  )),
  phot_g_mean_mag
) as phot_g_mean_mag_corr
from gaiaedr3.gaia_source
where random_index between 5000000 and 5999999
```

**Fig. A.1.** Example queries that can be submitted to the *Gaia* archive in ADQL to retrieve corrected *G*-band photometry.

```

import numpy as np

def correct_gband(bp_rp, astrometric_params_solved, phot_g_mean_mag, phot_g_mean_flux):
    """
    Correct the G-band fluxes and magnitudes for the input list of Gaia EDR3 data.

    Parameters
    -----
    bp_rp: float, array_like
        The (BP-RP) colour listed in the Gaia EDR3 archive.
    astrometric_params_solved: int, array_like
        The astrometric solution type listed in the Gaia EDR3 archive.
    phot_g_mean_mag: float, array_like
        The G-band magnitude as listed in the Gaia EDR3 archive.
    phot_g_mean_flux: float, array_like
        The G-band flux as listed in the Gaia EDR3 archive.

    Returns
    -----
    The corrected G-band magnitudes and fluxes. The corrections are only applied to
    sources with a 2-parameter or 6-parameter astrometric solution fainter than G=13,
    for which a (BP-RP) colour is available.

    Example
    """
    gmag_corr, gflux_corr = correct_gband(bp_rp, astrometric_params_solved,
                                           phot_g_mean_mag, phot_g_mean_flux)
    """
    if np.isscalar(bp_rp) or np.isscalar(astrometric_params_solved) or \
        np.isscalar(phot_g_mean_mag) or np.isscalar(phot_g_mean_flux):
        bp_rp = np.float64(bp_rp)
        astrometric_params_solved = np.int64(astrometric_params_solved)
        phot_g_mean_mag = np.float64(phot_g_mean_mag)
        phot_g_mean_flux = np.float64(phot_g_mean_flux)

    if not (bp_rp.shape == astrometric_params_solved.shape \
            == phot_g_mean_mag.shape == phot_g_mean_flux.shape):
        raise ValueError('Function parameters must be of the same shape!')

    do_not_correct = np.isnan(bp_rp) | (phot_g_mean_mag < 13) | \
        (astrometric_params_solved == 31)
    bright_correct = np.logical_not(do_not_correct) & (phot_g_mean_mag >= 13) & \
        (phot_g_mean_mag <= 16)
    faint_correct = np.logical_not(do_not_correct) & (phot_g_mean_mag > 16)
    bp_rp_c = np.clip(bp_rp, 0.25, 3.0)

    correction_factor = np.ones_like(phot_g_mean_mag)
    correction_factor[faint_correct] = 1.00525 - 0.02323*bp_rp_c[faint_correct] + \
        0.01740*np.power(bp_rp_c[faint_correct], 2) - \
        0.00253*np.power(bp_rp_c[faint_correct], 3)
    correction_factor[bright_correct] = 1.00876 - 0.02540*bp_rp_c[bright_correct] + \
        0.01747*np.power(bp_rp_c[bright_correct], 2) - \
        0.00277*np.power(bp_rp_c[bright_correct], 3)

    gmag_corrected = phot_g_mean_mag - 2.5*np.log10(correction_factor)
    gflux_corrected = phot_g_mean_flux * correction_factor

    return gmag_corrected, gflux_corrected

```

**Fig. A.2.** Python code for calculating the corrections to the G-band photometry for sources with two-parameter or six-parameter astrometric solutions.

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