Minutes of splinter meeting “Auxiliary Data”

held in Sitges on 27 Jan 2017, 9:00 – 12:00

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Contents

1 Introduction

We summarise the presentations and discussions from the splinter meeting on Auxiliary Data held during the DPAC Consortium Meeting 2017. Further information can be found in the presentation slides provided on SVN (with links in the text below). The agenda and list of participants is available from the GaiaWiki at `https://wiki.cosmos.esa.int/gaia-dpac/index.php/DPAC_Consortium_Meeting:2017:Splinters:Auxiliary_Data`. The meeting consisted of two parts. The first part (9:00 – 10:30, 26 participants) was about catalogues, ground-based data and reference stars (Sect. 2), and the second part (11:00 – 12:00, 23 participants) was about synthetic spectra (Sect. 3).

2 Catalogues, ground-based data and reference stars

2.1 Dimitri Pourbaix (CU4) – Spectroscopic binary data

An overview of the SB9 database (`http://sb9.astro.ulb.ac.be`) was given, which is used to supply auxiliary data to DPAC. The database currently contains ∼3500 systems, where components in hierarchical systems are counted separately. ∼4400 orbits are available (i.e. multiple orbits for the same system).

The web interface can be used to obtain data for individual systems (queried by identifier or coordinates), e.g. orbital elements from the original publications, radial velocity (RV) measurements, and RV graphs generated on the fly. Magnitudes can be inhomogeneous. The database can also be downloaded as a tarball, but this does not contain the RV measurements.

The catalogue is used in CU4 e.g. by Thierry Morel, and in CU6 (table *AuxSb2*), who have included a table in the DPC. CU8 could also make use of the database, although they do not need orbits, only positions and/or identifications of the systems. An HR diagram would be useful. Dimitri welcomes suggestions for systems/data (with references!) to be included in further updates.

2.2 Elena Pancino (CU5) – Gaia Spectrophotometric Standard Stars (SPSS)

The motivation for the SPSS Survey (Pancino et al., 2012; Altavilla et al., 2015) was to calibrate Gaia fluxes to 1–3%, using objects covering as many different spectral types as possible. It started in 2005 and was completed in 2015 (with 66 observing runs). It consisted of three parts (photometric monitoring, absolute photometry, and spectroscopy). Short-term photometric monitoring was done for about 170 stars, aiming for constancy within ±5 mmag. Indications for variability was found for 12 objects, including well-knows standards (Marinoni et al., 2016). Long-term photometric monitoring was abandoned, because this will be achieved with

Gaia itself. The data analysis for the absolute photometry is ongoing. The measurements and calibrations are completed, while literature comparison and quality checks are in progress. The data will be entered into the MDB. For the spectroscopic part, advanced reductions are ongoing, including corrections for slit loss, fringing, telluric absorption and second-order contamination. Flux calibration and flux table creation is ongoing as well (currently in the second round of analysis).

Preliminary data were released in 2013 as V0 (see EP-012) and contained about half of the sample (94 stars), those with the best data. The V1 SPSS release of 2015 (see SR-005) contained the same stars with extended wavelength coverage and better reductions and better calibration, to be used for calibration of Gaia DR1 and DR2 (i.e. integrated magnitudes). However, some reduction steps were not included yet (e.g. fringing correction). A second release (V2) to be used for DR3 calibration is in preparation. The SPSS data are stored in an archive at the ASDC (ASI Science Data Center), which is regularly updated with reduction products, and will be used for public spectra release (from $\sim$2018).

The CU5 calibration model was reviewed. The aim is to derive the Gaia instrument model. Two solutions are explored – the Montegriffo method in Bologna and the FAIM method in Barcelona. It was emphasised that the SPSS are optimal for flux calibration. However, other aspects of the instrument model (e.g the derivation of the LSF or the wavelength calibration) require additional calibration objects such as QSOs, hot stars, or galaxies, i.e. objects with emission lines. A discussion between CU5 and CU8 is ongoing, exploring various solutions including archive spectra and new observations. It was pointed out that CU5 does not have the manpower to carry out further observational campaigns.

The presentation is available at
`https://gaia.esac.esa.int/dpacsvn/DPAC/meetings/DPAC/Sitges-2017/Friday/Splinter_Auxiliary_Data/2017_PancinoCU5.pdf`.

Discussion: With regard to new observations, it was estimated that adding a new instrument would take a few years, mainly due to flux calibration efforts. For less ambitious flux calibration one could also add very accurate relative spectra. For 10 percent flux accuracy using one of the SPSS would be sufficient. People from CU5 can advise other groups who want to obtain flux-calibrated observations.

2.3 Olivier Marchal – CU6 catalogues of auxiliary data

CU6 has developed the following five different catalogues:

- Radial velocities – *AuxRadVel*
- Atmospheric parameters – *AuxAtmParams*
- G_{RVS} magnitudes of Hipparcos and IGSL stars – *AuxGrvs*

- High-resolution ground-based spectra – *AuxObsSpe*
- Spectroscopic binaries – *AuxSb2*

The first four are available in the MDB, and the last one as a DPC table. A description is available in the technical note OML-002.

AuxRadVel is used to validate radial velocities. It consists of two parts, one with better quality, which is used in the pipeline (∼8500 stars with RV errors less than 100 m/s). It will be extended in the near future. The second part is used for validation and consists of more than 60 000 stars. The data come from seven different compilations or surveys.

Needs for AuxRadVel: CU6 needs more faint stars with $G_{RVS} > 12$ and more cool and hot stars (M- and OBA stars, see specifications on slide 4 in presentation). R. Andrae recommended to contact Conny Aerts, who might have information on time-series observations of hot and cool stars obtained for asteroseismology.

AuxAtmParams is a selection of reference stars and templates containing 1.8 million stars with $T_{\rm eff}$ (from four different compilations or surveys) and more than 600 000 stars with $\log g$ and [Fe/H]. Rotational velocities are also included for ∼20 000 stars. It will be extended in the near future.

AuxGrvs is used to calibrate the G_{RVS} zero point and to validate G_{RVS}. It contains more than 19 million stars, including the SPSS from CU5, Hipparcos stars, and IGSL. G_{RVS} is calculated from V magnitudes and $V - I$ colours following CJ-041. The Hipparcos stars will be filtered for future versions (removing about 30% with inaccurate photometry). Currently rotational velocities from Hipparcos are used for calibration, but they should be replaced by something else.

AuxObsSpe is a library of 1100 NARVAL and Espadons normalised spectra. These are used in the pipeline to calibrate the LSF, and for validation. Recently, about 10% of the spectra with bad reduction were removed.

AuxSb2 is a catalogue of ∼300 SB2 systems selected from the SB9 catalogue (see Sect. 2.1). It is used to check binarity.

All catalogues have changed recently due to the new IDT cross-match. For the future, the CU9 cross-match will be used instead.

Future plans include to add RV faint, cool, and hot stars, to add RV variable stars, new APs from RAVE, add perhaps more observed spectra. The CU8 catalogue for emission line stars (Y. Frémat) will be used for classification.

All data are available at
https://gaia.esac.esa.int/dpacsvn/DPAC_tags/CU6/data/.

The presentation is available at
https://gaia.esac.esa.int/dpacsvn/DPAC/meetings/DPAC/Sitges-2017/Friday/Splinter_Auxiliary_Data/CU6AuxCataloguesStatus_OM.pdf.

2.4 Rene Andrae – CU8 validation in a nutshell

The CU8 validation procedure works as follows: Each module of Apsis (the CU8 pipeline) defines validation tests, then gathers external data needed for these tests. Then, the external data are cross-matched to the Gaia catalogue and the validation targets are requested from DPCC after processing. Due to the various methods available for parameter determination, the catalogue of validation targets is extremely inhomogeneous (see list for GSP-Phot in presentation, slide 3). A selection from the CU6 auxiliary catalogue of parameters was used (with constraints on existence of all three parameters and limits on their uncertainties). Some of the targets are used to test if the code fails in an informative way when it should (i.e. not-normal stars for which GSP-Phot was not designed to derive parameters). E. Pancino commented that Gaia-ESO data should be included.

The data are currently not publicly available, because of their inhomogeneity and because there is no documentation available. To request the data, please contact Morgan Fouesneau (fouesneau@mpia.de). To know more about the data you need to talk to CU8 people (via Morgan).

The presentation is available at
https://gaia.esac.esa.int/dpacsvn/DPAC/meetings/DPAC/Sitges-2017/Friday/Splinter_Auxiliary_Data/CU8-validation-data-Andrae.pdf.

2.5 Carine Babusiaux – CU9-WP944

This WP in CU9 uses cross-matched catalogues from WP974, complemented by compilations done using Vizier and Simbad. Home-made compilations include LMC and SMC members, dSph members, VLBI parallaxes and proper motions, and HST parallaxes. Added-value catalogues for the distance modulus exist (Cepheids, RR Lyrae, APOGEE, LAMOST, PASTEL, Gaia-ESO, stellar seismic indices database using Padova isochrones) or are to be compiled (eclipsing binaries). Low-extinction stars are selected from a 3D map for Hipparcos/TGAS stars created by R. Lallement, which will be public soon. The stars used for creating the map are also included among the CU8 validation targets.

The presentation is available at
https://gaia.esac.esa.int/dpacsvn/DPAC/meetings/DPAC/Sitges-2017/Friday/Splinter_Auxiliary_Data/wp944_auxiliary.pdf.

Discussion: M. Fouesneau commented that PAN-STARRS and SDSS are working on a large-scale cross-match with the Gaia catalogue, bringing the data onto the same scale. This will be published soon. T. Zwitter commented that GALAH is planning to publish 250 000 stars this summer. The list of positions of GALAH targets are included in the CU8 validation targets.

2.6 Discussion on sharing data

The Gaia Wiki page for this splinter meeting contains an overview table of auxiliary catalogues used in different CUs, with a short description and information on availability of the data[1]. It was suggested to move this table to a more central place, i.e. a new wiki page linked from the CU9 wiki pages. This could be either linked directly from the main CU9 wiki page[2], which seems most convenient, or from one of the CU9 work packages, e.g. `WP 957: Auxiliary Data`[3]. AI Aux17.1

It was proposed to include a section on auxiliary data in the Gaia archive as an internal table for DPAC use. X. Luri commented that a person is needed to organise this, and that he prefers having a single person (contact point) in DPAC who coordinates the activities related to Auxiliary Data for DR2 (similar to what was done for DR1 by E. Pancino). Also, a data model would be needed for this purpose. X. Luri will contact Rosanna Sordo on this issue, in coordination with the CU9 technical leader Jorgo Bakker. AI Aux17.2

Other places to share auxiliary data in free format are the DPAC SVN repository, and the GBOG server at ESAC (`ssh.esac.esa.int`[4]; GBOG representatives[5] have full read and write access).

3 Synthetic spectra

3.1 Ronny Blomme – Synthetic spectra in CU6

CU6 needs synthetic spectra to calibrate the CU6 pipeline and to determine the radial velocities (by comparing the observed spectrum against the radial-velocity shifted template spectrum). They use spectra in *StarNormal* format from a limited subset of the CU8 libraries[6] (FGK(M) stars, A stars, OB stars). There are two versions. Version 19.0.2 consists of three CU8 libraries

[1] `https://wiki.cosmos.esa.int/gaia-dpac/index.php/DPAC_Consortium_Meeting:2017:Splinters:Auxiliary_Data#Table_of_auxiliary_catalogues`
[2] `https://wiki.cosmos.esa.int/gaia-dpac/index.php/CU9:_Catalogue_Access`
[3] `https://wiki.cosmos.esa.int/gaia-dpac/index.php/CU9:950:957`
[4] read-only access with username `gbogcom` and password `gbog4dpce`
[5] `https://wiki.cosmos.esa.int/gaia-dpac/index.php/GBOG#GBOG_members`
[6] `https://wiki.cosmos.esa.int/gaia-dpac/index.php/CU8:_Spectral_libraries:_general`

(StarNormal01, StarNormal03, StarPeculiar01) and a PHOENIX library from CU2. Version 19.0.3 includes new model grids calculated specifically for this purpose (MARCS, OB, and A-type stars). In versions earlier than Version 19.0.x the libraries are partly overlapping. A solution to combine them in the best way was discussed. For example, CU8 uses each of the different grids to derive parameters and selects the parameters corresponding to the best fit. See presentation for figures showing the $T_{\rm eff}/\log g$ coverage of the two versions.

It is not yet decided which version will be used for DR2. Ascii versions are available on GaiaWeb at CNES. The Java code used to do the selection and the conversion to gbin files is available on SVN. M. Fouesneau commented that CU8 should use the same models for their simulations, to be consistent, i.e. the new model grids if CU6 decides to use Version 19.0.3.

Several types of stars are not covered by CU6 *StarNormal*, specifically cool giants, emission line stars, carbon stars, and B-type stars with a combination of absorption and emission. In these cases observed spectra could be used instead of synthetic spectra to generate templates.

The presentation is available at
`https://gaia.esac.esa.int/dpacsvn/DPAC/meetings/DPAC/Sitges-2017/Friday/Splinter_Auxiliary_Data/StarNormal_RB.pdf`.

Discussion: In CU8, there are numerous libraries available that have not yet been explored by CU6. The number of libraries will be reduced in the future to the essential ones needed for CU8 analysis[7]. R. Sordo is responsible for the CU8 libraries. The input spectra will eventually be published by CU9. This will require a data model. For current access in free format CU9 has an ftp server where the data can be stored. Access can be restricted to DPAC, but a minimum documentation is required (a template will be provided). AI Aux17.3

The publication of CU8 libraries will be part of a CU8-wide refereed article in connection with DR2. The role of CU6 in publishing libraries is to be decided.

3.2 Rene Andrae for Rosanna Sordo – CU8 stellar libraries

For an overview table and HR-diagram coverage see the presentation. A number of models lie in regions where we do not expect to observe known objects. Models with enhanced α-element abundances are also included (for use with GSP-Spec). There are also libraries for extra-galactic sources. These include empirical spectra.

On the CU8 wiki page there is a section about simulated data, which links to the page on CU8 training data[8], which includes a summary of requirements, validation reports, and other

[7] see `https://wiki.cosmos.esa.int/gaia-dpac/index.php/CU8_list_of_requested_libraries`

[8] `https://wiki.cosmos.esa.int/gaia-dpac/index.php/CU8:_Training_data`

information. This includes input data (i.e. spectral libraries). For further information and access to the data please contact R. Sordo and A. Vallenari directly.

The presentation is available at
`https://gaia.esac.esa.int/dpacsvn/DPAC/meetings/DPAC/Sitges-2017/Friday/Splinter_Auxiliary_Data/CU8-simulation-data-Sordo.pdf`.

Discussion: CU4 also uses synthetic spectra, but also needs limb darkening. Therefore they are doing their own calculations. At some point the different calculations should be compared.

Actions

Id	Actionee	Due Date	Action
Aux17.1	X. Luri	2017-02-20	In coordination with J. Bakker, decide on location in Gaia Wiki for auxiliary data overview table and move it there.
Aux17.2	X. Luri	2017-02-20	Contact R. Sordo and J. Bakker to create a Gaia archive section for catalogues of auxiliary data and to coordinate the activities related to Auxiliary Data.
Aux17.3	R. Blomme and X. Luri	2017-02-28	Contact R. Sordo to organise the DPAC-internal publication of CU8 spectral libraries on the CU9 ftp server.

References

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[SR-005], Ragaini, S., Pancino, E., Altavilla, G., et al., 2016, *First post-launch release (V1) of Gaia external Spectro-Photometric Standard Stars*, GAIA-C5-TN-OABO-SR-005, URL http://www.rssd.esa.int/cs/livelink/open/3384056

Acronyms

The following table has been generated from the on-line Gaia acronym list:

Acronym	Description
AP	Astrophysical parameter
ASDC	ASI Science Data Centre
ASI	Agenzia Spaziale Italiana
CNES	Centre National d'Etudes Spatiales (France)
CU	Coordination Unit (in DPAC)
DPAC	Data Processing and Analysis Consortium
DPC	Data Processing Centre
DPCC	Data Processing Centre CNES
ESAC	European Space Astronomy Centre (VilSpa)
GBOG	Ground-Based Observations for Gaia (DPAC)
GSPPhot	Generalised Stellar Parametriser PHOTometry
GSPSpec	Generalised Stellar Parametriser SPECtroscopy
HR	Hertzsprung-Russell (diagram)
HST	Hubble Space Telescope
IDT	Initial Data Treatment (Image Dissector Tube in Hipparcos scope)
IGSL	Initial Gaia Source List
LMC	Large Magellanic Cloud (special, high-density area on the sky)
LSF	Line Spread Function
MDB	Main DataBase
QSO	Quasi-Stellar Object
RAVE	RAdial Velocity Experiment
RV	Radial velocity

SB2	Double-lined Spectroscopic Binary
SDSS	Sloan Digital Sky Survey
SMC	Small Magellanic Cloud (special, high-density area on the sky)
SPSS	Spectro-Photometric Standard Star
SVN	SubVersioN
VLBI	Very Long Baseline Interferometry
WP	Work Package