

1.1_ATLAS

January 18, 2018

1 HATLAS-SGP master catalogue

1.1 Preparation of ATLAS/VST data

ATLAS/VST catalogue: the catalogue comes from dmu0_ATLAS.

In the catalogue, we keep:

- The identifier (it's unique in the catalogue);
- The position;
- The stellarity;
- The aperture corrected aperture magnitude in each band (2")
- The Petrosian magnitude to be used as total magnitude (no "auto" magnitude is provided).

We don't know when the maps have been observed. We will use the year of the reference paper.

This notebook was run with herschelhelp_internal version:
44f1ae0 (Thu Nov 30 18:27:54 2017 +0000)

1.2 I - Column selection

```
/opt/anaconda3/envs/herschelhelp_internal/lib/python3.6/site-packages/astropy/table/column.py:10
Check the NumPy 1.11 release notes for more information.
ma.MaskedArray.__setitem__(self, index, value)
```

Out[6]: <IPython.core.display.HTML object>

1.3 II - Removal of duplicated sources

We remove duplicated objects from the input catalogues.

```
/opt/anaconda3/envs/herschelhelp_internal/lib/python3.6/site-packages/astropy/table/column.py:10
Check the NumPy 1.11 release notes for more information.
ma.MaskedArray.__setitem__(self, index, value)
```

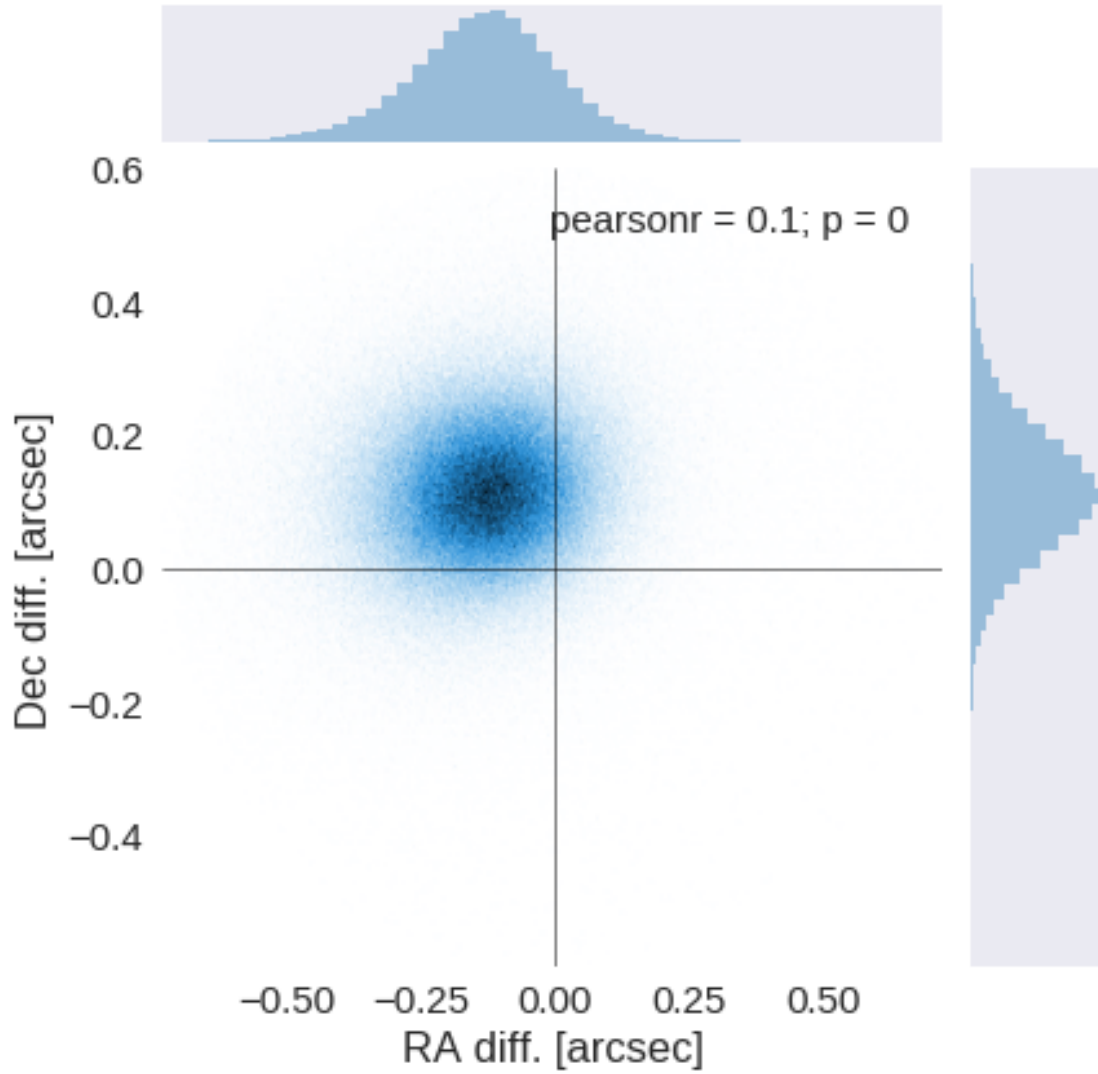
The initial catalogue had 7937203 sources.

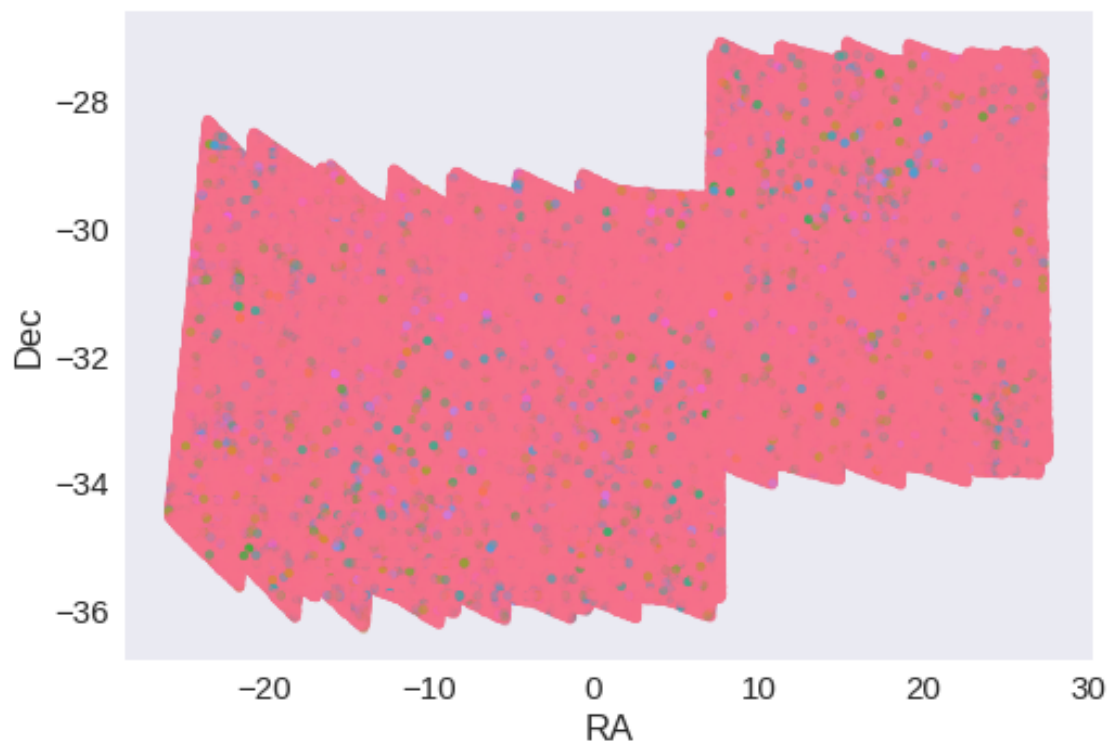
The cleaned catalogue has 7562634 sources (374569 removed).

The cleaned catalogue has 362887 sources flagged as having been cleaned

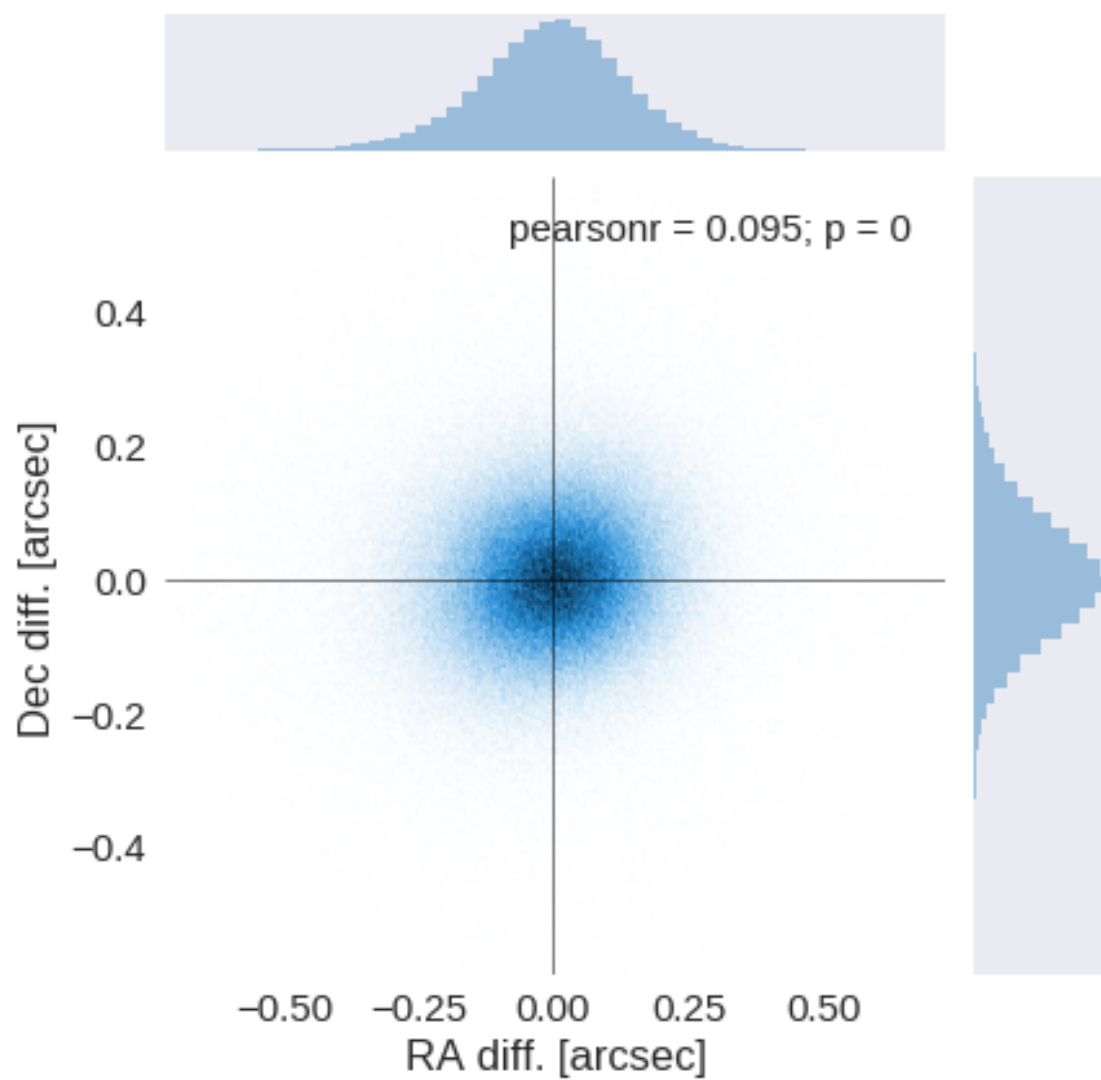
1.4 III - Astrometry correction

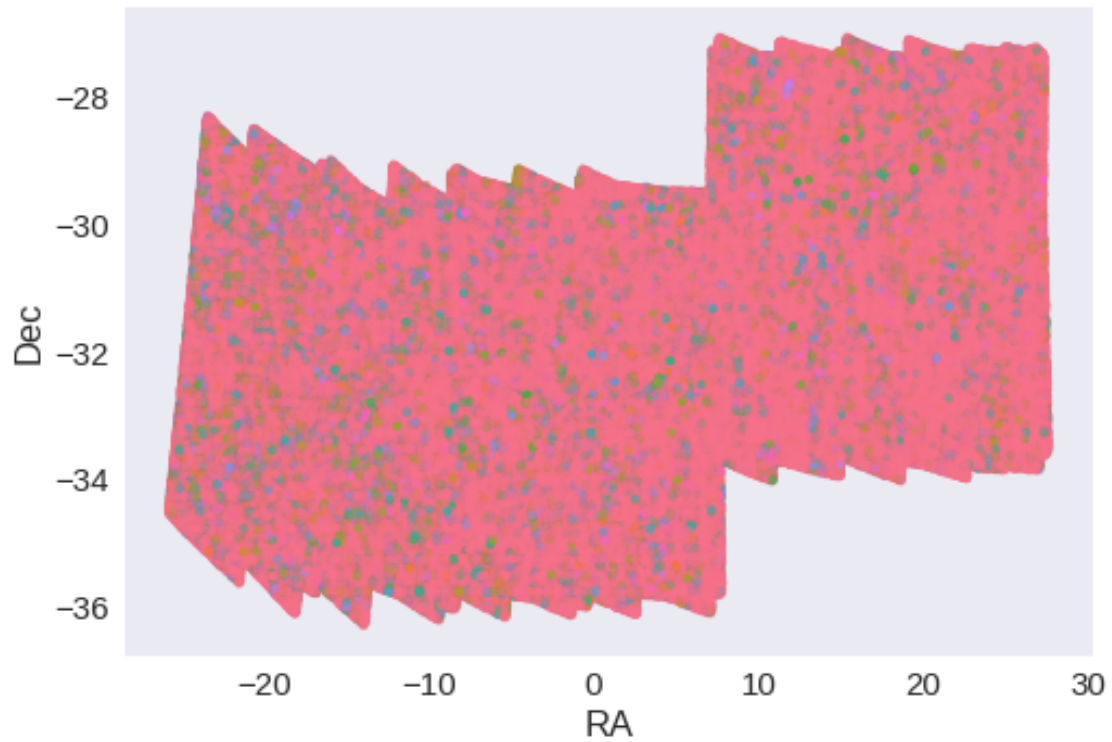
We match the astrometry to the Gaia one. We limit the Gaia catalogue to sources with a g band flux between the 30th and the 70th percentile. Some quick tests show that this give the lower dispersion in the results.





RA correction: 0.12983922202352005 arcsec
Dec correction: -0.11415334424285106 arcsec





1.5 IV - Flagging Gaia objects

754069 sources flagged.

1.6 V - Flagging objects near bright stars

2 VI - Saving to disk

1.2_KIDS

January 18, 2018

1 HATLAS-SGP master catalogue

1.1 Preparation of KIDS/VST data

Kilo Degree Survey/VLT Survey Telescope catalogue: the catalogue comes from dmu0_KIDS.

In the catalogue, we keep:

- The identifier (it's unique in the catalogue);
- The position;
- The stellarity;
- The aperture corrected aperture magnitude in each band (10 pixels = 2")
- The Petrosian magnitude to be used as total magnitude (no "auto" magnitude is provided).

We take 2014 as the observation year from a typical image header.

This notebook was run with herschelhelp_internal version:
44f1ae0 (Thu Nov 30 18:27:54 2017 +0000)

1.2 I - Column selection

```
/opt/herschelhelp_internal/herschelhelp_internal/utils.py:76: RuntimeWarning: divide by zero encountered in log
  magnitudes = 2.5 * (23 - np.log10(fluxes)) - 48.6
/opt/herschelhelp_internal/herschelhelp_internal/utils.py:76: RuntimeWarning: invalid value encountered in log
  magnitudes = 2.5 * (23 - np.log10(fluxes)) - 48.6
/opt/herschelhelp_internal/herschelhelp_internal/utils.py:80: RuntimeWarning: invalid value encountered in log
  errors = 2.5 / np.log(10) * errors_on_fluxes / fluxes
```

Out[6]: <IPython.core.display.HTML object>

1.3 II - Removal of duplicated sources

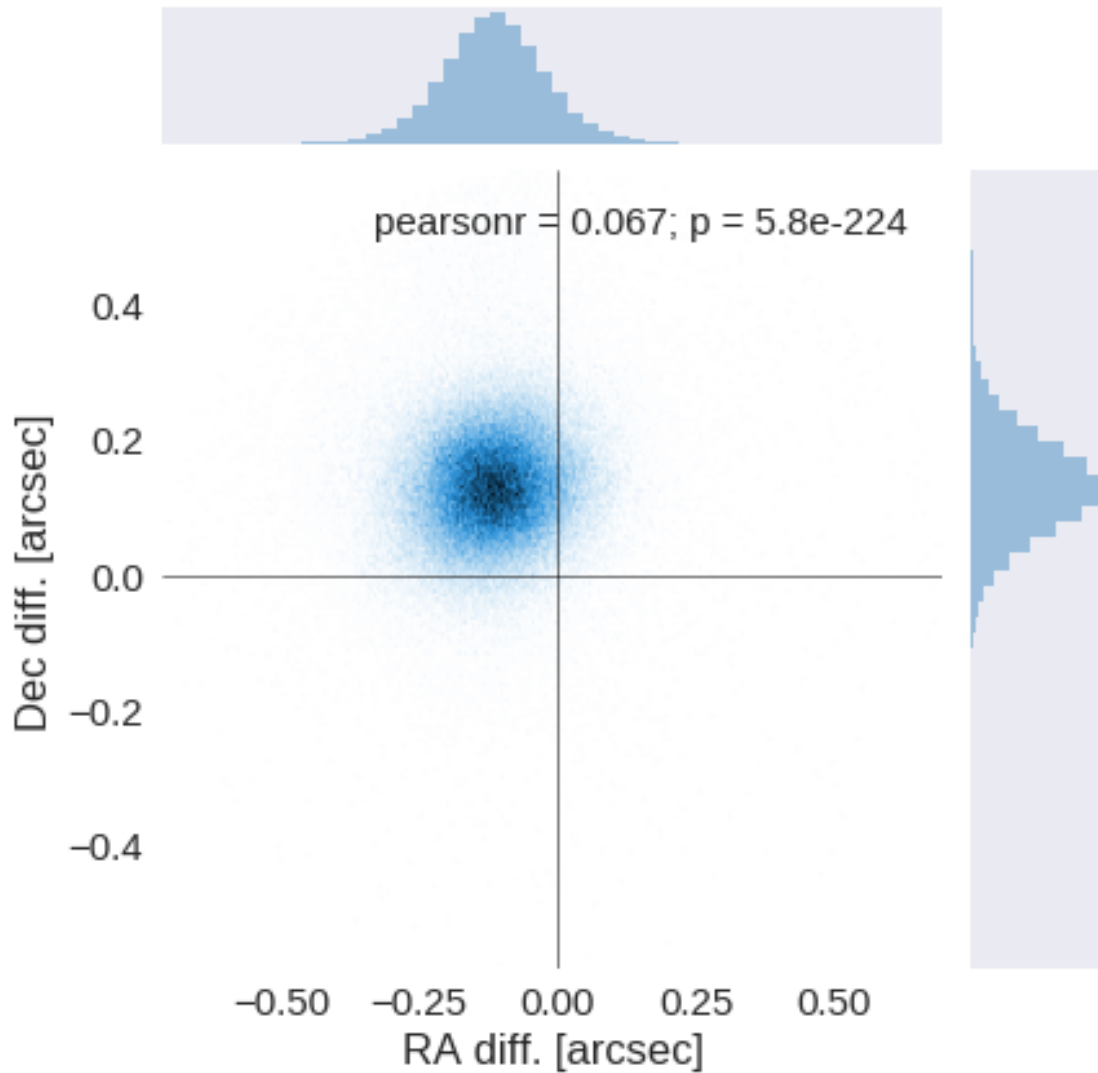
We remove duplicated objects from the input catalogues.

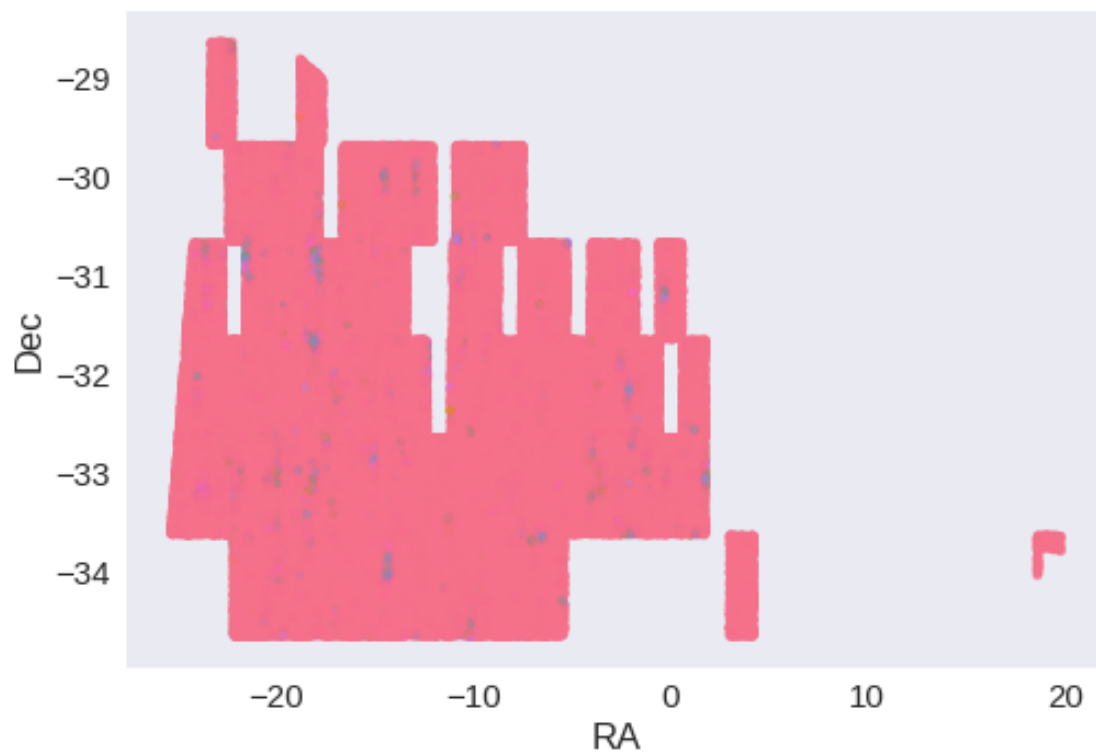
```
/opt/anaconda3/envs/herschelhelp_internal/lib/python3.6/site-packages/astropy/table/column.py:10:
Check the NumPy 1.11 release notes for more information.
  ma.MaskedArray.__setitem__(self, index, value)
```

The initial catalogue had 9667089 sources.
The cleaned catalogue has 9666966 sources (123 removed).
The cleaned catalogue has 123 sources flagged as having been cleaned

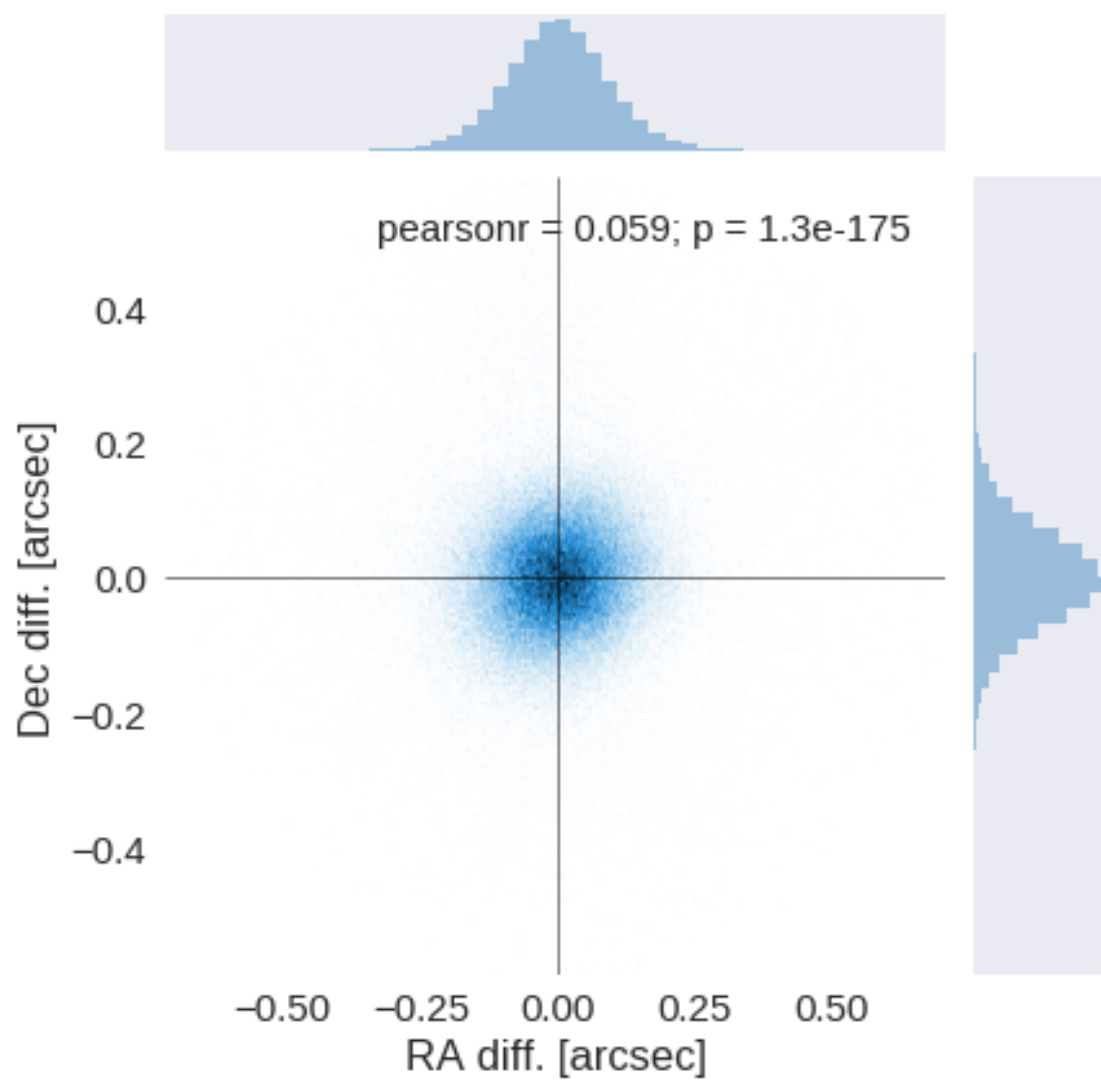
1.4 III - Astrometry correction

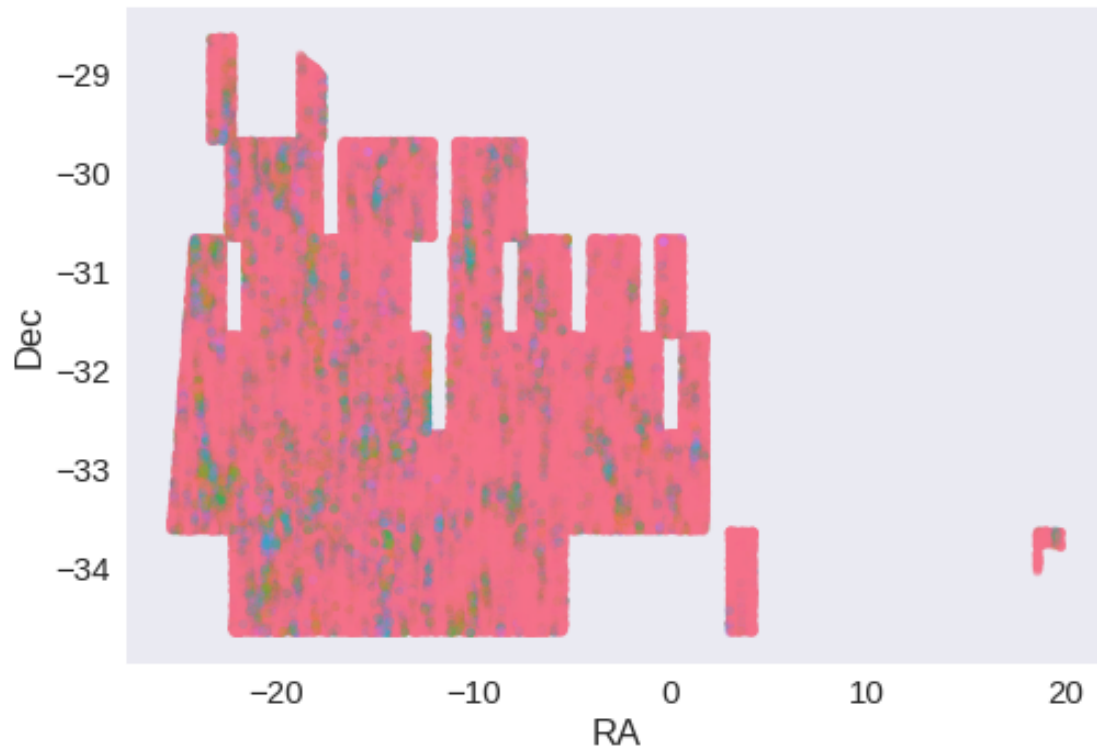
We match the astrometry to the Gaia one. We limit the Gaia catalogue to sources with a g band flux between the 30th and the 70th percentile. Some quick tests show that this give the lower dispersion in the results.





RA correction: 0.11440588580171607 arcsec
Dec correction: -0.12961663829287318 arcsec





1.5 IV - Flagging Gaia objects

240146 sources flagged.

1.6 V - Flagging objects near bright stars

2 VI - Saving to disk

1.3_PanSTARRS-3SS

January 18, 2018

1 HATLAS-SGP master catalogue

1.1 Preparation of Pan-STARRS1 - 3pi Steradian Survey (3SS) data

This catalogue comes from `dmu0_PanSTARRS1-3SS`.

In the catalogue, we keep:

- The `uniquePspSTid` as unique object identifier;
- The r-band position which is given for all the sources;
- The grizy `<band>FApMag` aperture magnitude (see below);
- The grizy `<band>FKronMag` as total magnitude.

The Pan-STARRS1-3SS catalogue provides for each band an aperture magnitude defined as “In PS1, an ‘optimal’ aperture radius is determined based on the local PSF. The wings of the same analytic PSF are then used to extrapolate the flux measured inside this aperture to a ‘total’ flux.”

The observations used for the catalogue were done between 2010 and 2015 ([ref](#)).

This notebook was run with `herschelhelp_internal` version:
44f1ae0 (Thu Nov 30 18:27:54 2017 +0000)

1.2 I - Column selection

```
/opt/anaconda3/envs/herschelhelp_internal/lib/python3.6/site-packages/astropy/table/column.py:10
```

Check the NumPy 1.11 release notes for more information.

```
ma.MaskedArray.__setitem__(self, index, value)
```

Out[6]: <IPython.core.display.HTML object>

1.3 II - Removal of duplicated sources

We remove duplicated objects from the input catalogues.

```
/opt/anaconda3/envs/herschelhelp_internal/lib/python3.6/site-packages/astropy/table/column.py:10
```

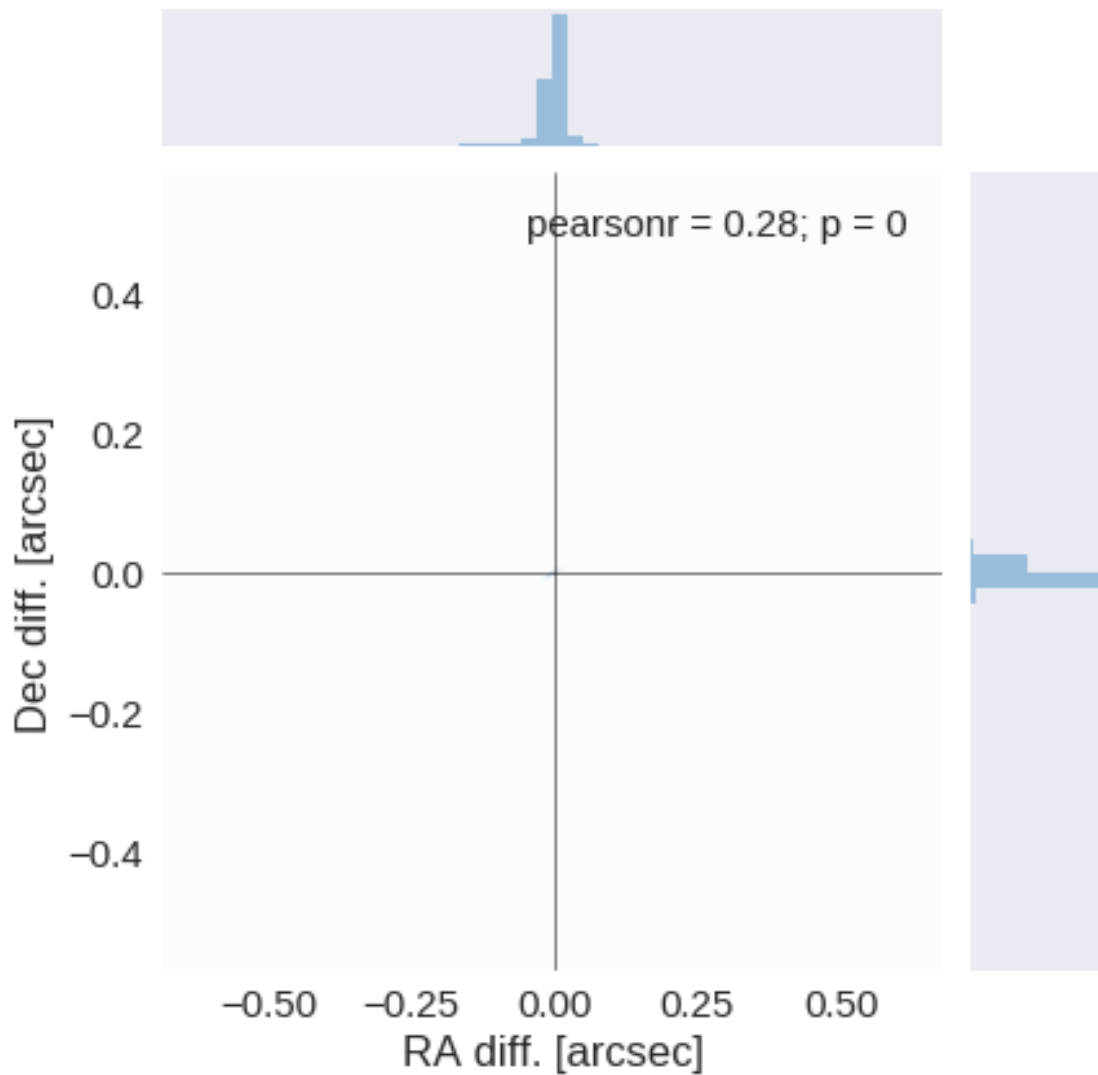
Check the NumPy 1.11 release notes for more information.

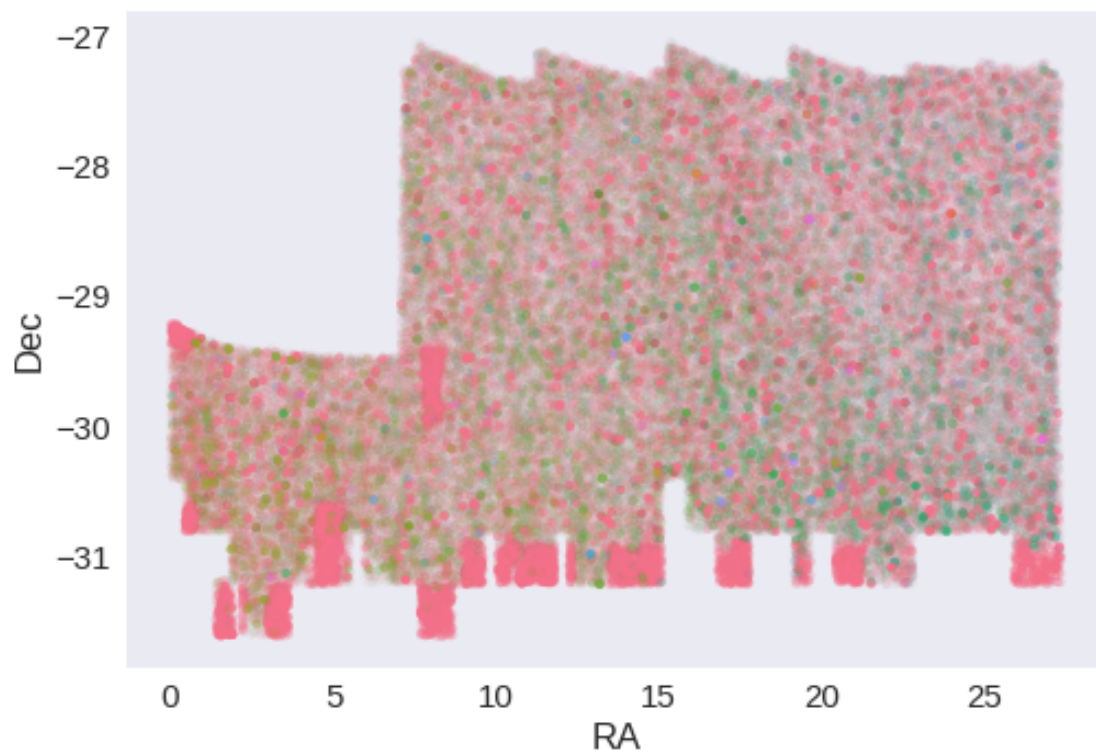
```
ma.MaskedArray.__setitem__(self, index, value)
```

The initial catalogue had 1176484 sources.
The cleaned catalogue has 1175819 sources (665 removed).
The cleaned catalogue has 665 sources flagged as having been cleaned

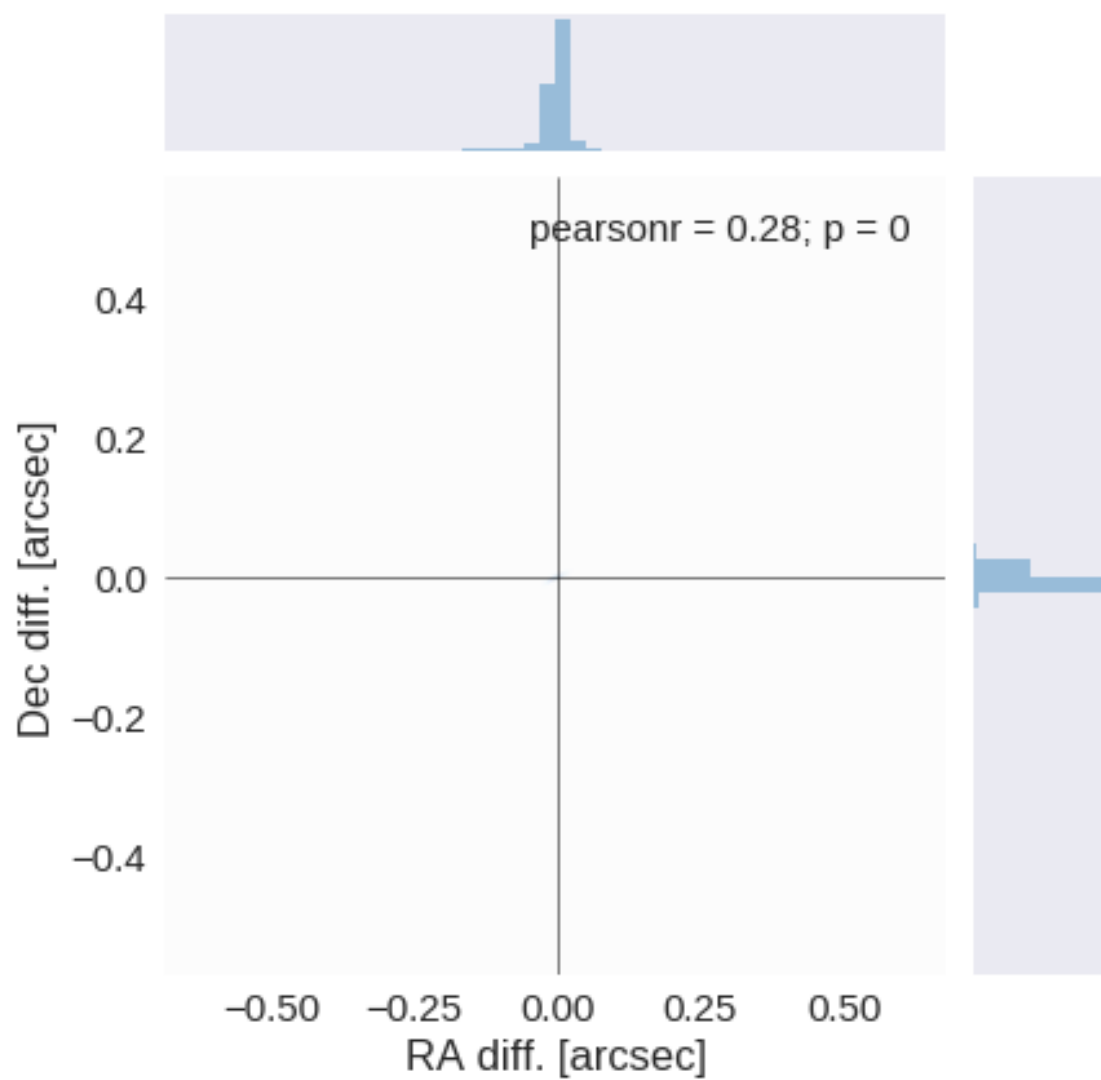
1.4 III - Astrometry correction

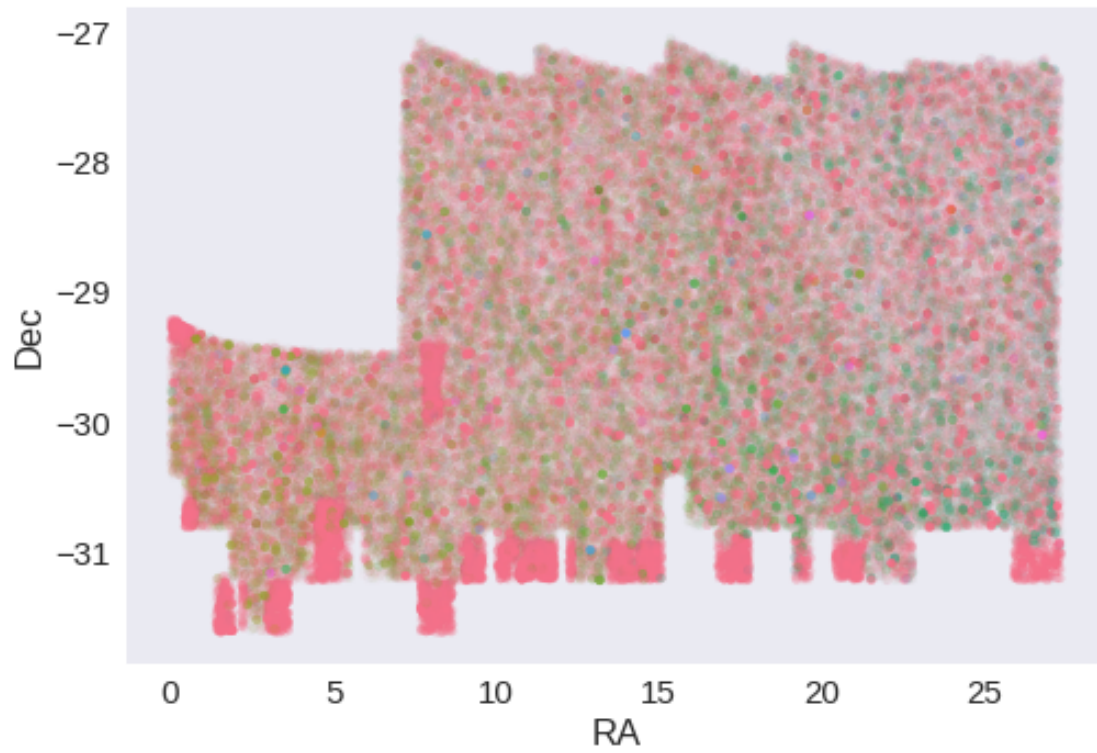
We match the astrometry to the Gaia one. We limit the Gaia catalogue to sources with a g band flux between the 30th and the 70th percentile. Some quick tests show that this give the lower dispersion in the results.





RA correction: 5.458857685880503e-05 arcsec
Dec correction: -0.0004657485661141436 arcsec





1.5 IV - Flagging Gaia objects

176621 sources flagged.

1.6 V - Flagging objects near bright stars

2 VI - Saving to disk

1.4_VISTA-VIKING

January 18, 2018

1 HATLAS-SGP master catalogue

1.1 Preparation of VIKING data

VISTA telescope/VIKING catalogue: the catalogue comes from dmu0_VIKING.

In the catalogue, we keep:

- The identifier (it's unique in the catalogue);
- The position;
- The stellarity;
- The magnitude for each band.
- The kron magnitude to be used as total magnitude (no “auto” magnitude is provided).

We don't know when the maps have been observed. We will use the year of the reference paper.

This notebook was run with herschelhelp_internal version:
44f1ae0 (Thu Nov 30 18:27:54 2017 +0000)

1.2 I - Column selection

```
/opt/anaconda3/envs/herschelhelp_internal/lib/python3.6/site-packages/astropy/table/column.py:10
Check the NumPy 1.11 release notes for more information.
ma.MaskedArray.__setitem__(self, index, value)
```

Out[7]: <IPython.core.display.HTML object>

1.3 II - Removal of duplicated sources

We remove duplicated objects from the input catalogues.

```
/opt/anaconda3/envs/herschelhelp_internal/lib/python3.6/site-packages/astropy/table/column.py:10
Check the NumPy 1.11 release notes for more information.
ma.MaskedArray.__setitem__(self, index, value)
```

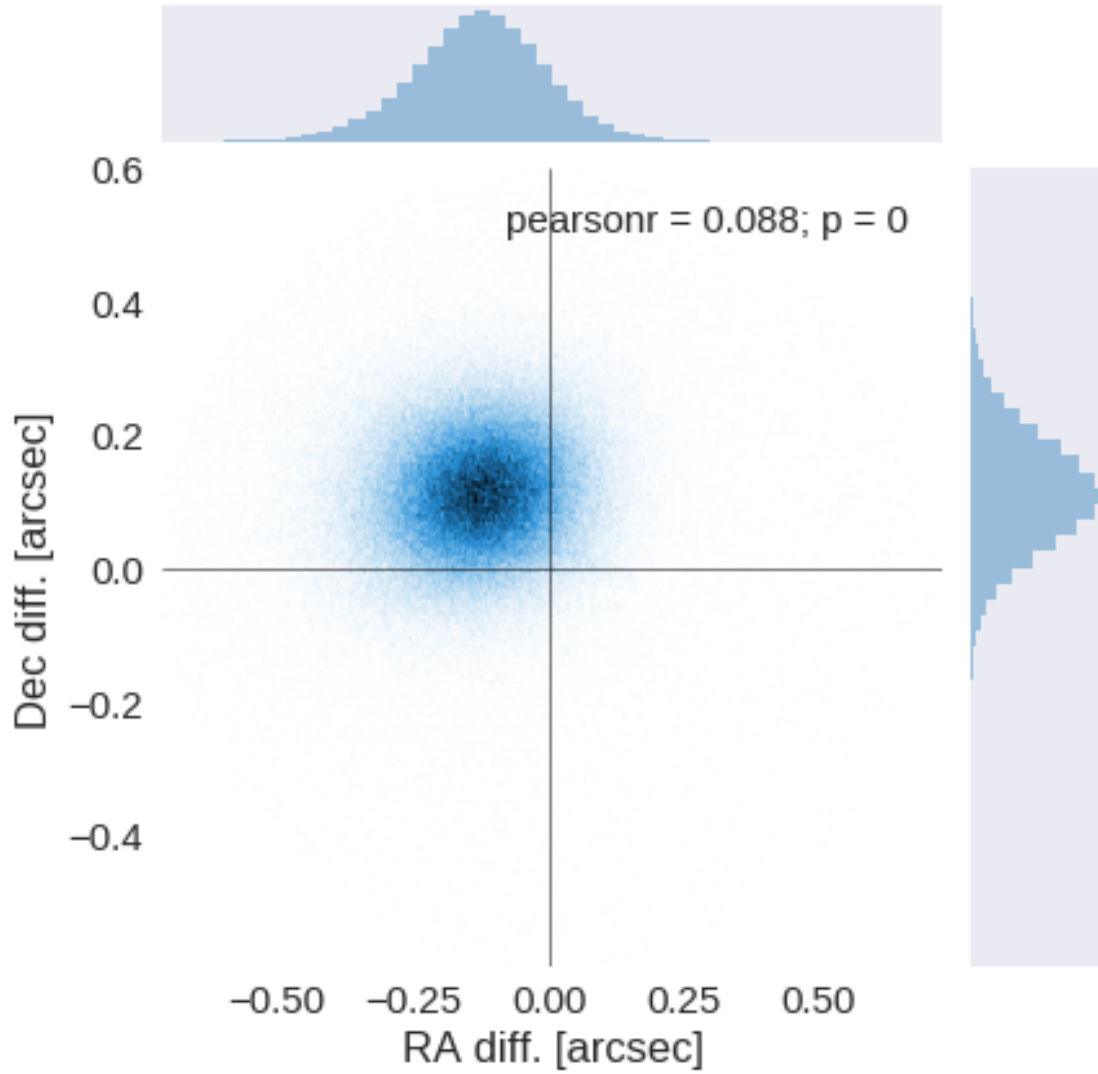
The initial catalogue had 12380676 sources.

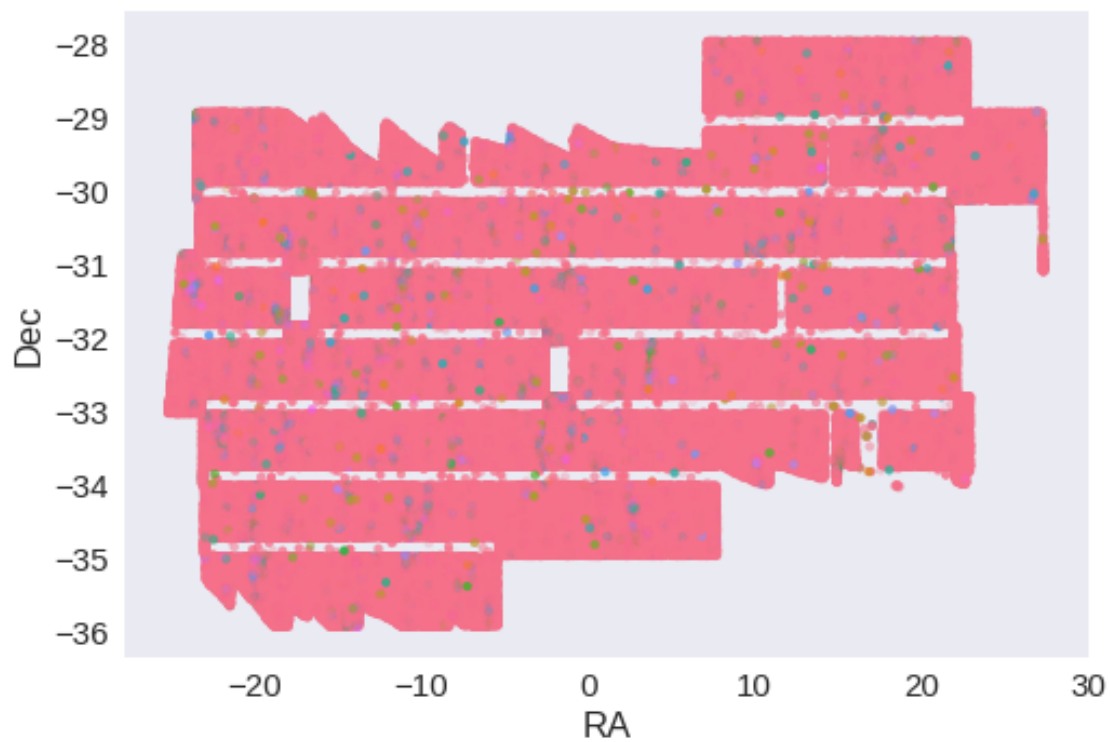
The cleaned catalogue has 12350404 sources (30272 removed).

The cleaned catalogue has 30050 sources flagged as having been cleaned

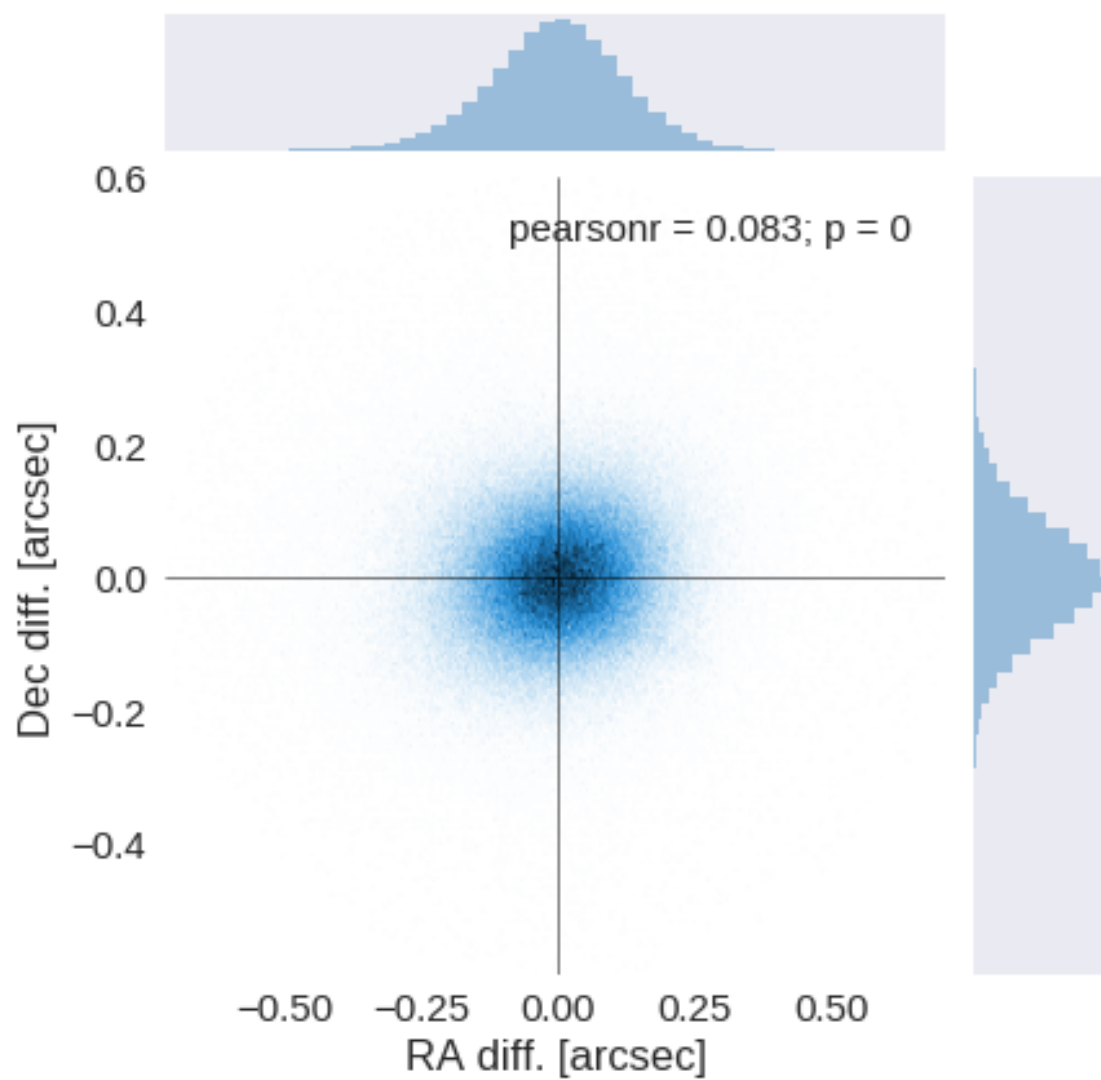
1.4 III - Astrometry correction

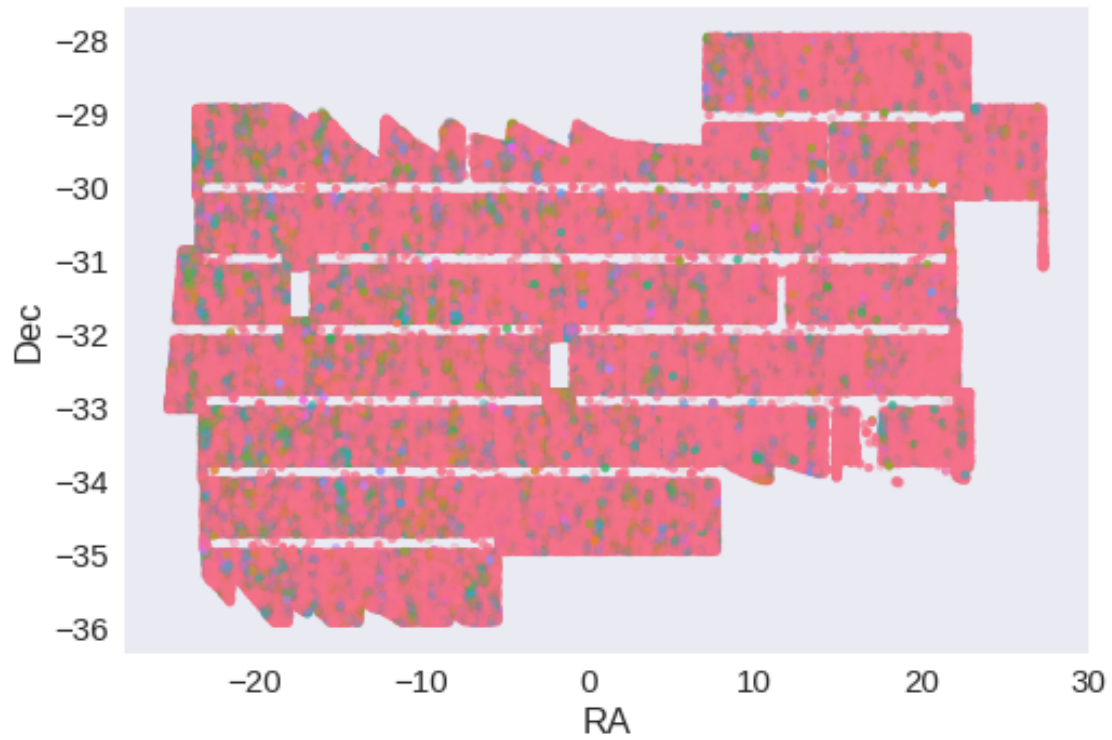
We match the astrometry to the Gaia one. We limit the Gaia catalogue to sources with a g band flux between the 30th and the 70th percentile. Some quick tests show that this give the lower dispersion in the results.





RA correction: 0.12487526277027428 arcsec
Dec correction: -0.11282892556891966 arcsec





1.5 IV - Flagging Gaia objects

468817 sources flagged.

1.6 V - Flagging objects near bright stars

2 VI - Saving to disk

1.5_DES

January 18, 2018

1 HATLAS-SGP master catalogue

1.1 Preparation of DES data

Blanco DES catalogue: the catalogue comes from `dmu0_DES`.

In the catalogue, we keep:

- The identifier (it's unique in the catalogue);
- The position;
- The G band stellarity;
- The magnitude for each band.
- The auto/kron magnitudes/fluxes to be used as total magnitude.
- The PSF fitted magnitudes/fluxes are used as aperture magnitudes.

We don't know when the maps have been observed. We will take the final observation date as 2017.

1.2 I - Column selection

1.3 II - Removal of duplicated sources

We remove duplicated objects from the input catalogues.

1.4 III - Astrometry correction

We match the astrometry to the Gaia one. We limit the Gaia catalogue to sources with a g band flux between the 30th and the 70th percentile. Some quick tests show that this give the lower dispersion in the results.

1.5 IV - Flagging Gaia objects

1.6 V - Flagging objects near bright stars

2 VI - Saving to disk

2_Merging

January 18, 2018

1 HATLAS-SGP master catalogue

This notebook presents the merge of the various pristine catalogues to produce HELP master catalogue on GAMA-09.

1.1 I - Reading the prepared pristine catalogues

1.2 II - Merging tables

We first merge the optical catalogues and then add the infrared ones: CFHTLenS, CFHTLS, DECaLS, HSC, KIDS, PanSTARRS, UKIDSS-LAS, VISTA-VHS, and VISTA-VIKING.

At every step, we look at the distribution of the distances to the nearest source in the merged catalogue to determine the best crossmatching radius.

1.2.1 ATLAS

1.2.2 Add KIDS

1.2.3 Add PanSTARRS

1.2.4 Add VIKING

1.2.5 Add DES

1.2.6 Cleaning

When we merge the catalogues, astropy masks the non-existent values (e.g. when a row comes only from a catalogue and has no counterparts in the other, the columns from the latest are masked for that row). We indicate to use NaN for masked values for floats columns, False for flag columns and -1 for ID columns.

1.3 III - Merging flags and stellerity

Each pristine catalogue contains a flag indicating if the source was associated to a another nearby source that was removed during the cleaning process. We merge these flags in a single one.

Each pristine catalogue contains a flag indicating the probability of a source being a Gaia object (0: not a Gaia object, 1: possibly, 2: probably, 3: definitely). We merge these flags taking the highest value.

Each pristine catalogue may contain one or several stellerity columns indicating the probability (0 to 1) of each source being a star. We merge these columns taking the highest value.

1.4 IV - Adding E(B-V) column

1.5 V - Adding HELP unique identifiers and field columns

1.6 VI - Choosing between multiple values for the same filter

1.6.1 ATLAS and KIDS

The ATLAS and KIDS surveys are both on the VLT Survey Telescope (VST). KIDS is significantly deeper so we take KIDS fluxes if available.

Survey	Bands observed
ATLAS	u, ul, griz
KIDS	ugri

1.7 VII.a Wavelength domain coverage

We add a binary `flag_optnir_obs` indicating that a source was observed in a given wavelength domain:

- 1 for observation in optical;
- 2 for observation in near-infrared;
- 4 for observation in mid-infrared (IRAC).

It's an integer binary flag, so a source observed both in optical and near-infrared by not in mid-infrared would have this flag at $1 + 2 = 3$.

Note 1: The observation flag is based on the creation of multi-order coverage maps from the catalogues, this may not be accurate, especially on the edges of the coverage.

Note 2: Being on the observation coverage does not mean having fluxes in that wavelength domain. For sources observed in one domain but having no flux in it, one must take into consideration the different depths in the catalogue we are using.

1.8 VII.b Wavelength domain detection

We add a binary `flag_optnir_det` indicating that a source was detected in a given wavelength domain:

- 1 for detection in optical;
- 2 for detection in near-infrared;
- 4 for detection in mid-infrared (IRAC).

It's an integer binary flag, so a source detected both in optical and near-infrared by not in mid-infrared would have this flag at $1 + 2 = 3$.

Note 1: We use the total flux columns to know if the source has flux, in some catalogues, we may have aperture flux and no total flux.

To get rid of artefacts (chip edges, star flares, etc.) we consider that a source is detected in one wavelength domain when it has a flux value in **at least two bands**. That means that good sources will be excluded from this flag when they are on the coverage of only one band.

1.9 VIII - Cross-identification table

We are producing a table associating to each HELP identifier, the identifiers of the sources in the pristine catalogue. This can be used to easily get additional information from them.

1.10 IX - Adding HEALPix index

We are adding a column with a HEALPix index at order 13 associated with each source.

1.11 X - Saving the catalogue

3_Checks_and_diagnostics

January 18, 2018

1 HATLAS-SGP master catalogue

1.1 Checks and diagnostics

1.2 0 - Quick checks

1.3 I - Summary of wavelength domains

1.4 II - Comparing magnitudes in similar filters

The master list is composed of several catalogues containing magnitudes in similar filters on different instruments. We are comparing the magnitudes in these corresponding filters.

1.4.1 II.a - Comparing depths

We compare the histograms of the total aperture magnitudes of similar bands.

1.4.2 II.b - Comparing magnitudes

We compare one to one each magnitude in similar bands.

1.5 III - Comparing magnitudes to reference bands

Cross-match the master list to SDSS and 2MASS to compare its magnitudes to SDSS and 2MASS ones.

1.5.1 III.b - Comparing J and K bands to 2MASS

The catalogue is cross-matched to 2MASS-PSC withing 0.2 arcsecond. We compare the VISTA total J and K magnitudes to those from 2MASS.

The 2MASS magnitudes are “*Vega-like*” and we have to convert them to AB magnitudes using the zero points provided on [this page](#):

Band	F - 0 mag (Jy)
J	1594
H	1024
Ks	666.7

In addition, VISTA uses a K band whereas 2MASS uses a Ks (“short”) band, [this page](#) give a correction to convert the K band in a Ks band with the formula:

$$K_{s(2MASS)} = K_{UKIRT} + 0.003 + 0.004 * (JK)_{UKIRT}$$

1.6 IV - Comparing aperture magnitudes to total ones.

1.7 V - Color-color and magnitude-color plots