Bright star mask (ver. 20200303)

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Caveats:

This document is primarily based on an HSC internal data release (S19A release to be specific), in which a different sky subtraction algorithm from HSCLA is applied. The plots in this document may thus look slightly different if the HSCLA data are used, but the majority are completely relevant. In fact, the only changes we expect are (1) HSCLA does not need the *dip* component, and (2) the *halo* component has a different size, and the size of the halo mask has been updated for HSCLA.

Artifacts around bright object



There are some artifacts around bright star. These artifacts will give rise to fake sources and under/over estimate of flux densities for real sources. The affected sources should be masked.

Other artifacts

for HSC-Y



Hereafter, we call "**y-scratch**"

The CCDs become optically thin at long wavelengths and photons could interact with the wiring on the back of the CCDs.

Investigation of the affected region

- Input target sources
 - GAIA DR2 with good photometric data
 - selection criteria

phot_g_mean_flux_over_error > 50

AND phot_bp_mean_flux_over_error > 20

AND phot_rp_mean_flux_over_error > 20

AND phot_bp_rp_excess_factor<1.3+0.06*power(phot_bp_mean_mag-phot_rp_mean_mag,2)

AND phot_bp_rp_excess_factor>1.0+0.015*power(phot_bp_mean_mag-phot_rp_mean_mag,2)

- GAIA magnitudes were converted to HSC magnitudes
- Target region
 - for brighter side (<11 mag): the Equator regions in Wide layer from the HSC-SSP data.
 - for fainter side(>= 11 mag): D/UD-COSMOS, SXDS, and DEEP2 regions from HSC-SSP.

Investigation of the affected region



top: Normalized radial profile around bright stars. Median values of 97 sources with i-band magnitudes of 5.0--5.9

bottom: The histogram (dN/rdr) of SSP-detected sources around bright stars. Mean values of 97 sources.

Three features at 160, 260, and 320 arcsec can be seen in both the profile and histogram.

Histogram value of ~0.2 is thought to be the sky.

Three features on coadd image



Plots for various brightness



Three features are still on 160, 260, and 320 arcsec. The distances are fixed and independent from brightness -> optical ghost

Plots for various brightness



For magnitude of 7, it is hard to recognize the 260 and 320 arcsec features. For magnitude of 8, the 160 arcsec feature still remains, but is almost disappeared.

Mask sizes



Band dependency

Mask for blooming

Blooming (or bleed trail) is parallel to the CCD wiring. The length depends on the source's brightness and positions on the CCD. The maximum length is about 10 arcmin.

~10 arcmin

The distortion is also complication for the outskirts of the FoV.

The best practice is put some flags at the CCD analysis stage (i.e. corr image), not on the warp/coadd image. We can make "typical" masks from coadd image.

Range of the blooming effect

The 2-D histogram (dN/dr) of SSP-sources around bright stars. Normalized at the sky value. Mean values of 97 sources with i-band magnitudes of 5.0--5.9

Fake detections arise along horizontal.

Profiles along horizontal (blue) and vertical (orange) lines of the 2-D histogram (bottom), and their ratio (top).

Length of the blooming effect reaches 600 arcsec for sources with magnitude of 5.

Scratches on Y-band image

The Y-band scratch is perpendicular to the blooming.

The 2-D histogram of SSP-sources around bright stars. Normalized at the sky value. Mean values of 130 sources with y-band magnitudes of 5.0--5.9

There is no excess fake sources along the vertical. May be affect only for photometry?

Stacked image

Stacked image of 130 sources with y-band magnitudes of 5.0--5.9.

The length of this stray light is about 320 arcsec for 5 mag sources. This length varies with source's brightness, and maximum length is about 320 arcsec.

Summary

- We made bright star masks.
 - Reference catalog was created from GAIA DR2.
 - Bright galaxies were not considered.
- There are halo, ghost, blooming, and y-scratch masks.
 - The halo and ghost masks will work fine.
 - The blooming masks should also work, but perhaps not perfect.
 - Since the y-scratch does not seem to contribute fake sources, this mask is applied only for yband.
- The new masks will be installed to the database (new table).
 - 3 or 4 columns for each band.
 - i_mask_halo, i_mask_ghost, i_mask_blooming (for g, r, i, and z-bands)
 - y_mask_halo, y_mask_ghost, y_mask_blooming, y_mask_scratch (for y-band)
 - Additional one summary column.
 - i_mask_any (= i_mask_halo OR i_mask_ghost OR i_mask_blooming)