PyASB:
The All Sky Brightness free software

UNIVERSIDAD COMPLUTENSE MADRID

STARS4ALL

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Light Pollution: Theory, Modelling and Measurements

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PyASB

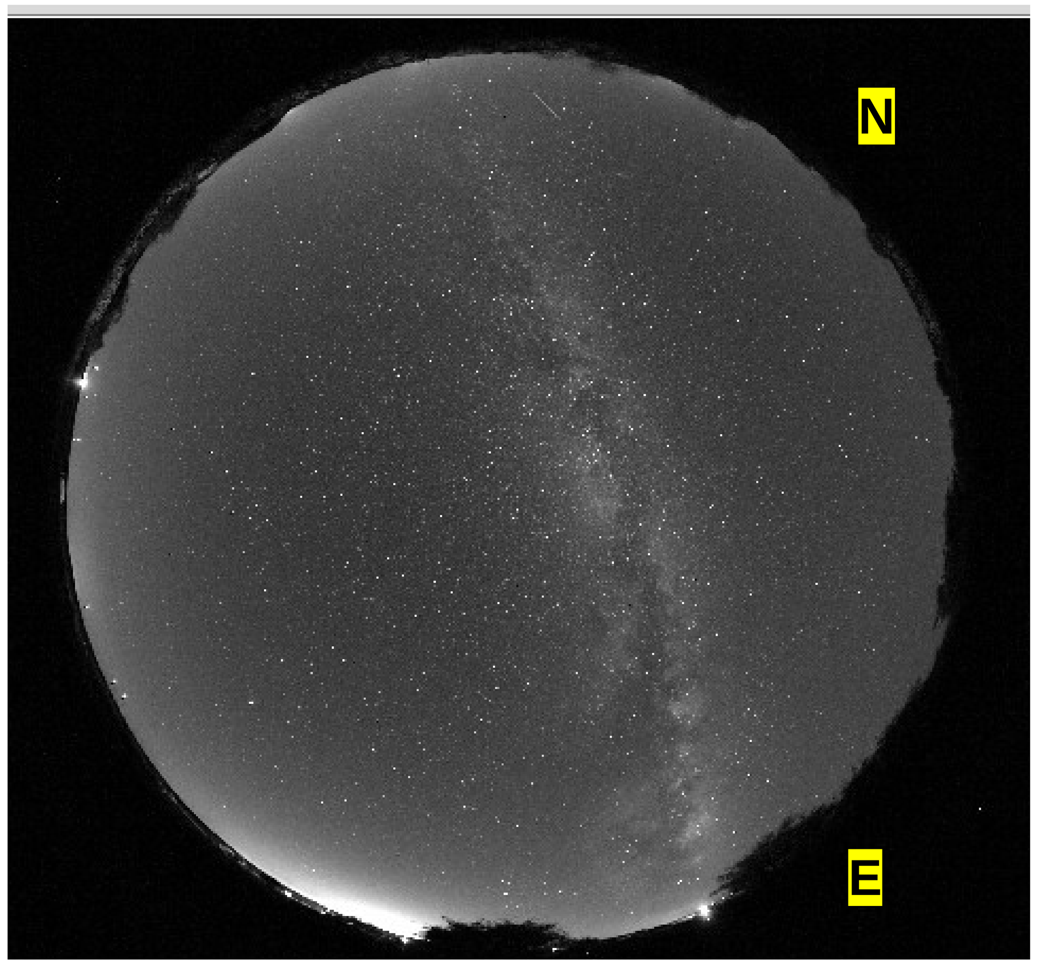
PyASB is a Python open source program, developed by M. Nievas https://eprints.ucm.es/24626/, created to process images obtained with the All-Sky Transmission Monitor (AstMon), a commercial all-sky camera designed by the company *iTec Astronomica SL.* and provide measurements of night-sky brightness and extinction

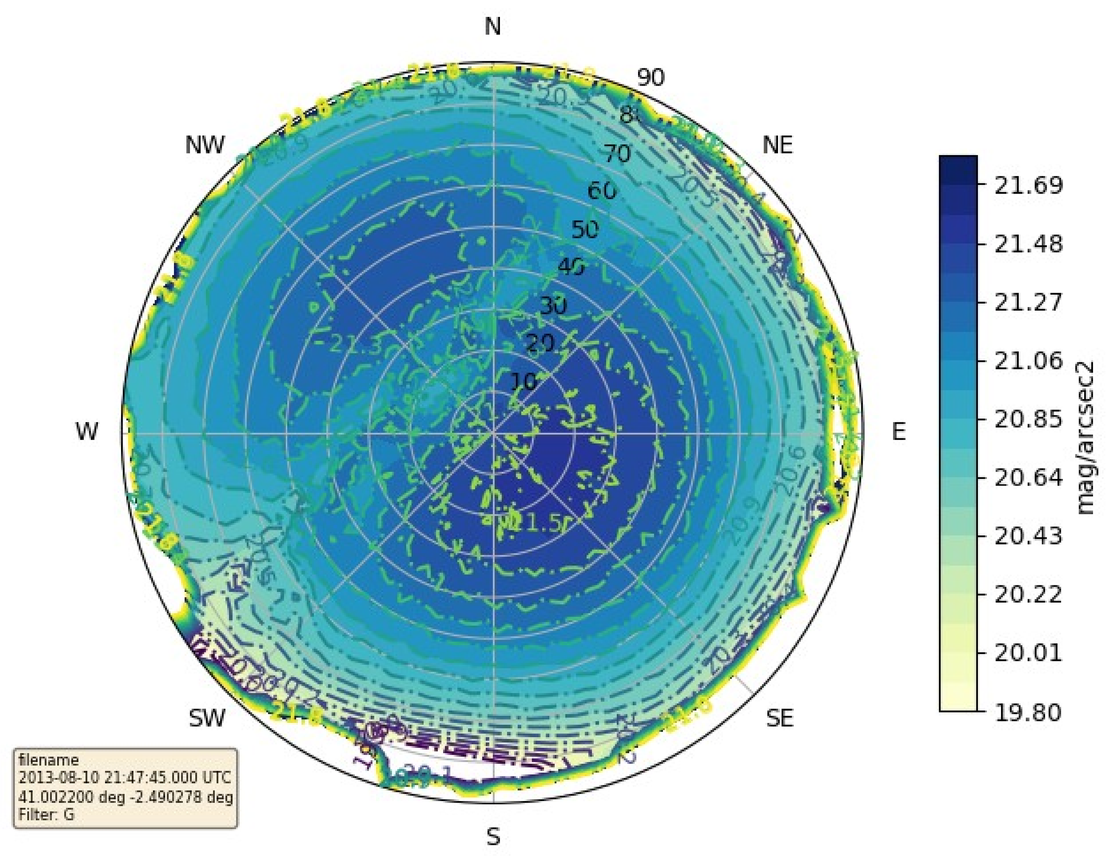
The program is compatible with Python 3, and is released under GPLv3.

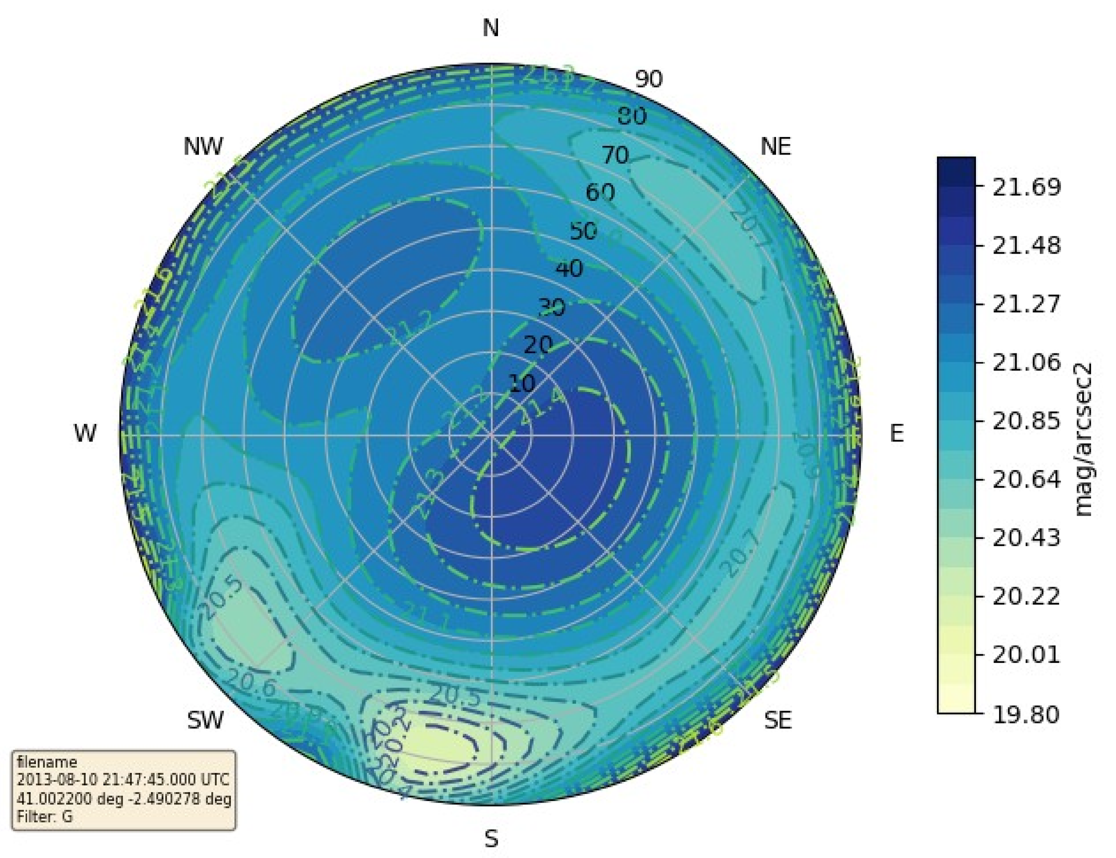
We have **extended the functionality of the software** to work with **RAW pictures taken with all-sky digital cameras** (DSLR fitted with fisheye lenses).

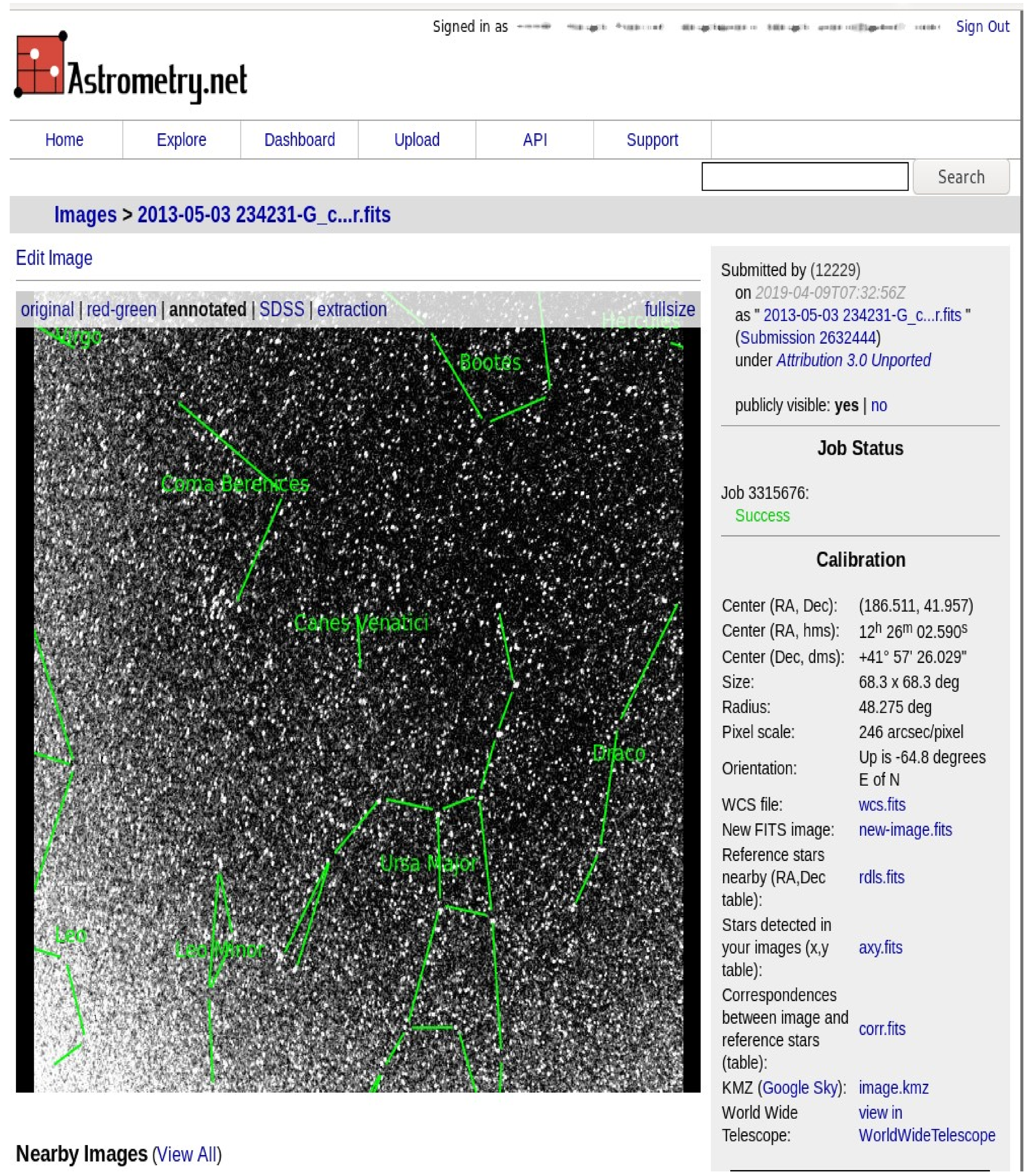
Our long term goal is to create a **web service** that performs the required processing and **returns the user a calibrated image**

The image below is the G channel of exposure obtained with a Canon EOS 5D. We have calibrations (vignetting, see below) for this family of cameras. We expect to test with other cameras soon.







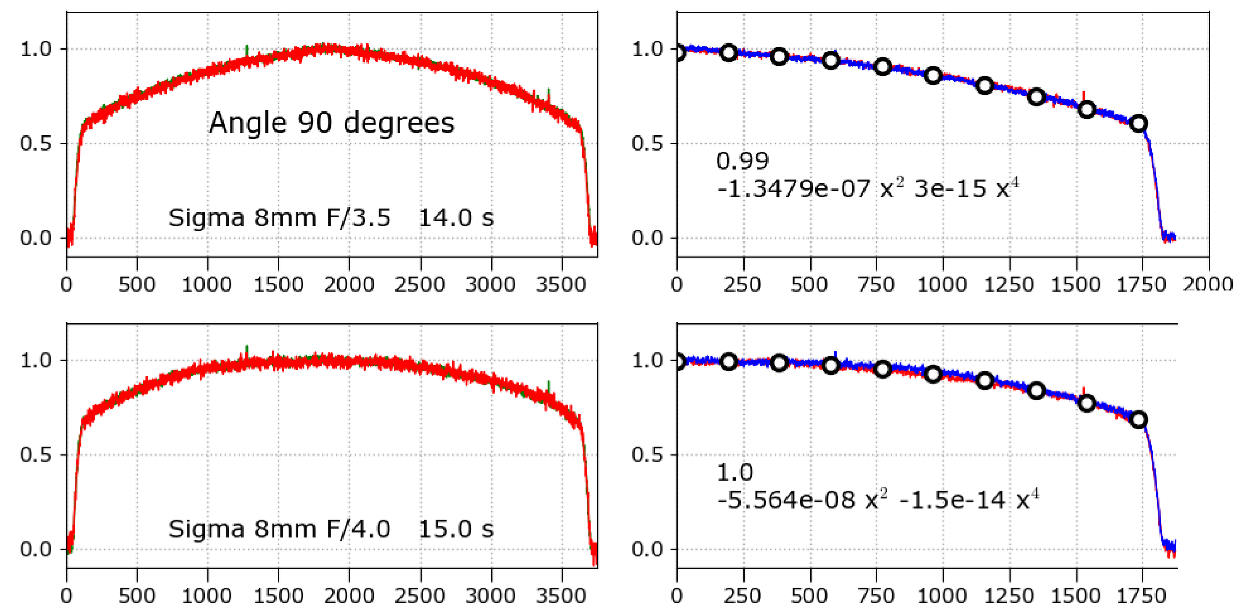


Vignetting correction

Vignetting in the image is an importante factor, as it will affect the outer parts of the image, and it bias the measured photometric extinction to higher values.

We have measured the vignetting correction for our camera and lens and we apply it automatically based on the metadata of the image.

We show below radial polynomials for different focal ratios.



Sky brightness map

With the phometric zeropoint and the astrometric calibration of the image we can compute brightness in absolute units.

On the top, left, we show **the sky brightness map corresponding to our original image** (left on top).
In this case, we measure after median filtering to avoid including light of the stars.

The levels of the contours have been chosen to show the contribution of the Milky Way (crossing from SW to NE).

On bottom left, we show the sky brightness of the same image **averaged with the beam of a TESS photometer** of 17 square degrees FWHM.

This image is smoother due to the large size of the FOV of the photometer.

The sky brightness measured simulating a photometer is slightly brighter than the background measured filtering the stars.
With the photometer we are taking into account also the flux of the stars, although diluted in the beam of the photometer.

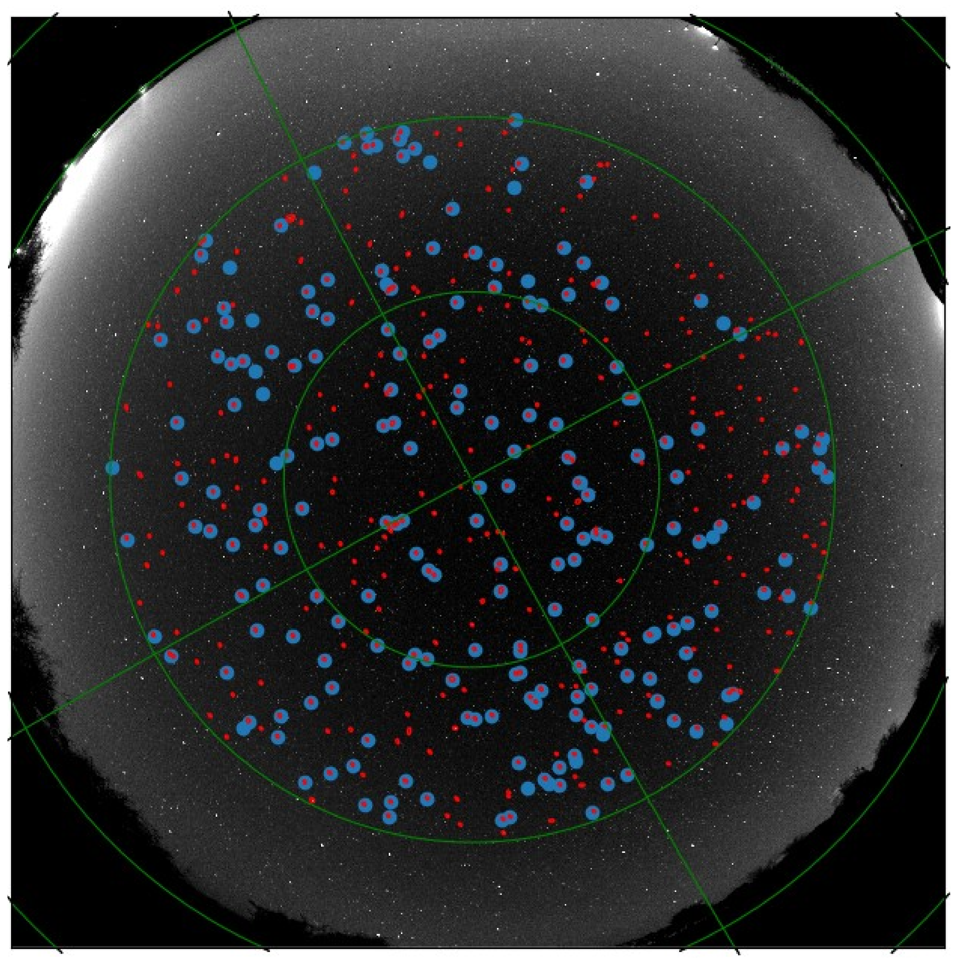
Initial field recognition and astrometry

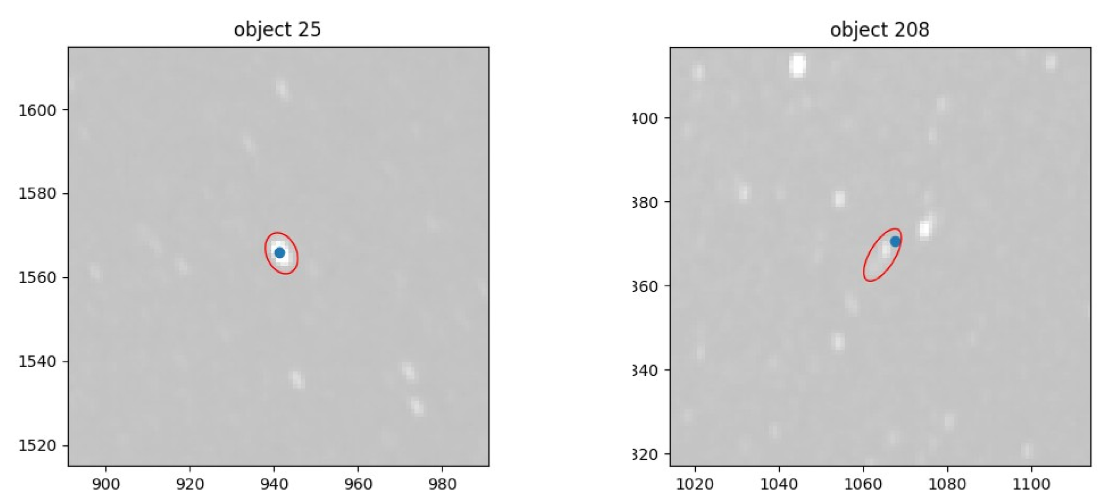
We use the API of astrometry.net to upload a cutout of the center of image, where distortions are spected to smaller. The service finds a first astrometric solution for the center of the image. The solution is computed as a tangent plane projection, so is not directly usable by us. Nevertheles, the service provides tables with the RA/Dec coordinates of the stars detected in the image.

Together with **Earth location** of the image, and the **absolute time**, we can compute the expected coordinates of the stars in the local altitude-azimuth frame.

Given the known *xy* coordinates of the stars and the expected altitude-azimuth angles, we can **fit the parameters of the projection**: center of projection, scale and the three Euler angles that describe the position of the zenith.

The scale of the projection is expected to remain constant, given a camera model and lens. The center of projection and position of the zenith can change slightly depending on the conditions of the observation.





Photometric calibration

The astrometric calibration allows us to compute the position of stars from a well known photometric catalog (Ducati 2002) in the image (blue circles on figure on top). We also perform automatic object detection on the image to find actual stars in the image (red dots).

Then we **match the detected stars with the expected position of the star from the catalogue**. Tipically the star can be found around a few pixels from the expected position (*object 25*, on the left). Nevertheless, the match can be difficult, specially far from the center (*object 208*, on the right), due to bad mapped distortions or source confusion. All the problems with source matching will affect the phometric calibration.

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ACTION

European Commission

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