Astreaks: Astrometry of NEOs with trailed background stars

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Can astrometry be performed on non-sideral images?

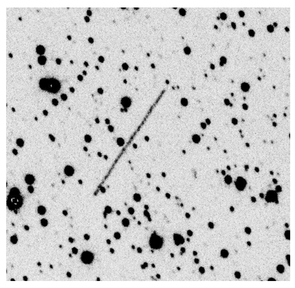
We present, ASTREAKS!

The Astreaks algorithm offers a robust solution for precise astrometry of fastmoving NEOs, particularly in **non-sidereal images**, overcoming limitations of existing techniques.

Need for Astreaks

Challenges in sidereal tracking of asteroids:

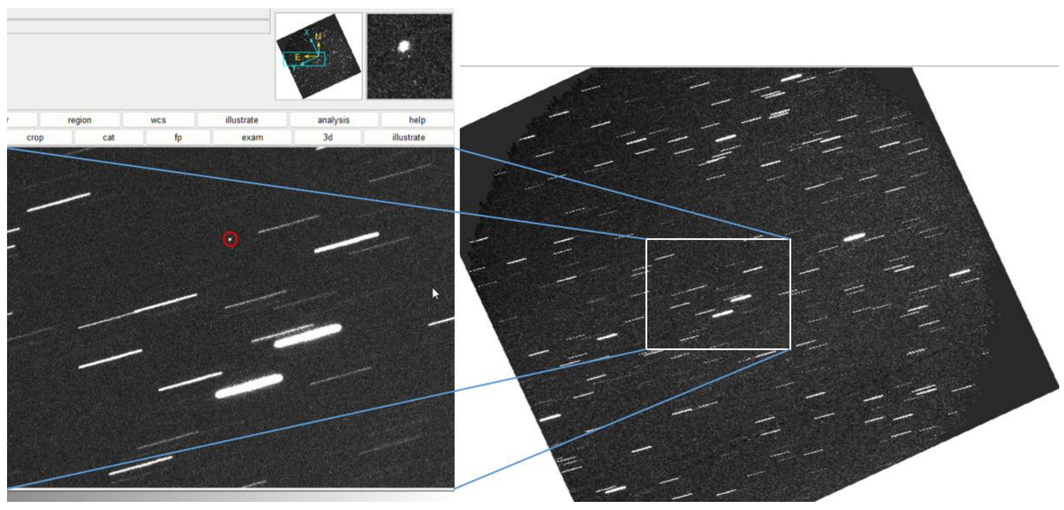
- High apparent motion of NEOs.
- Resulting in low SNR of the target.



Sidereal observation of Asteroid 2011GA

Non-sidereal tracking:

- **High SNR** values.
- The background stars leave streaks.
- Difficult to perform astrometry.



Validation Results

Number of NEOs	125
Number of Images	396
Success Rate (Published NEOs)	100%
Standard Deviation (O-C)	**0.52”**
O-C residuals < 2”	**100%**

Future Scope

- Astreaks aims to improve accessibility by offering **online availability** while also focusing on refining its photometry aspect for accurate and reliable results.

Reference

- Sharma, Kritti, et al. "Astreaks: astrometry of NEOs with trailed background stars." Monthly Notices of the Royal Astronomical Society 524.2 (2023): 2651-2660.

Astreaks Workflow

Streak Spread Function(SSF)

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Background Estimation

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Source Detection

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Solving Synthetic Image

SSF Generation

$$\text{streak length} = \text{obs time} \times \sqrt{(raRate \times cos(dec))^2 + decRate^2}$$

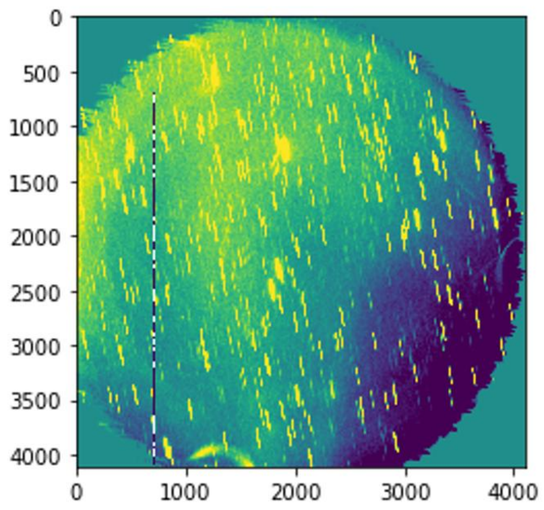
$$SSF = motionVector * PSF$$

Motion Vector and PSF

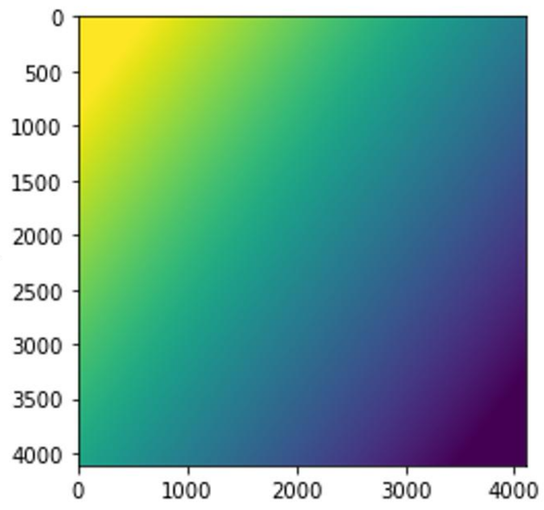
SSF

Background Estimation

- Considers factors like **moon distance** and streak length of stars to avoid gradients.
- Image divided into uniform grids; mode of pixel values calculated for each grid represents the background for one grid.



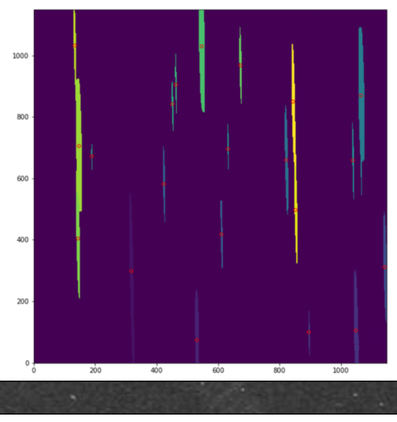
Science Image



Estimated Background

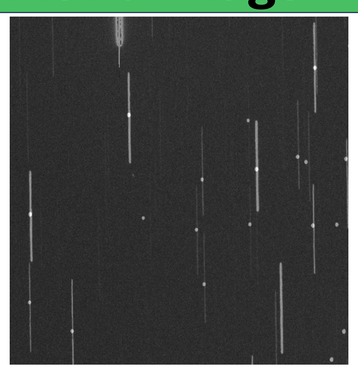
Source Detection

- Image segmentation uses normalized SSF as kernel to group pixels into regions(streaks).
- Deblending of images assists in distinguishing nearby streaks.



Generating and Solving Synthetic Image

- Catalogue sources injected onto centroid coordinates in empty image.
- Synthetic image solved for World Coordinate System (WCS) using astrometry.net's engine.



Overlap of Science and synthetic image