

IAA-PDC-25-04-163

Identifying potential NEOs based on their single-tracklet motion

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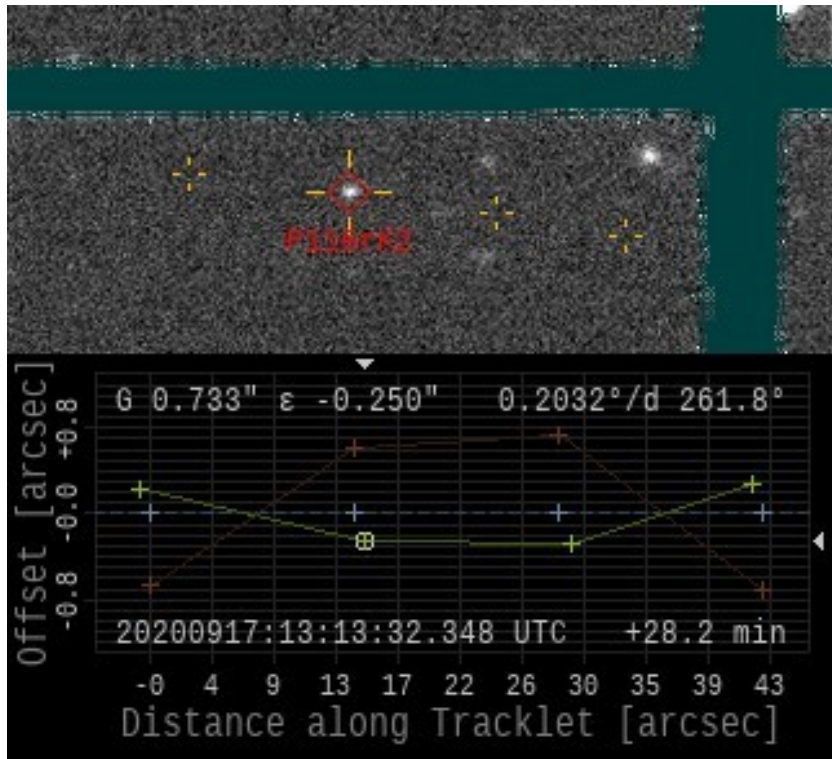
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Introduction

- We want to increase NEO discoveries by searching for objects which might not otherwise be found due to their low scores
 - The ‘digest2’ score (0-100) classifies tracklets based on motion
 - Must be > 65 to post on the NEO Confirmation Page
 - For ≤ 65 , NEOs can be “hidden in plain sight”
 - Two techniques to search for low score NEOs
 - Multi-night tracklet linking from the Isolated Tracklet File (ITF)
 - Single-night detections with motion that deviates from being linear -- these suggest proximity to the observer

Tracklet Curvature



- Motion appears to curve, with the deviation from a Great Circle ideally larger than the pixel scale
- Due to proximity to the Earth
 - Good indicator for potential NEOs independent of score
- Cross-track and along-track accelerations are separate
 - The former is a better metric
 - But we fit the motion with both
 - Require 4+ detections

2020 SO = P116rK2

- Motion ω 0.20°/day, ρ 262°, $V \sim 21.5$, $\Delta \sim 0.03$ au
 - NEO score 1, RMS 0".72 → but detection images looked okay
 - Force-posted to the NEOCP, then found precoveries in PS archive
- Designated as 2020 SO = P116rK2
 - But eventually it was realised to be artificial and was deleted
 - Upper stage Centaur from 1966 Surveyor 2 spacecraft launch
- Fitted $a_{\perp} = 0.312 \pm 0.128$, improved to 0.338 ± 0.019 ...
 - ... after not assuming astrometric uncertainties
- Shows that objects close to Earth can be found based on a single tracklet

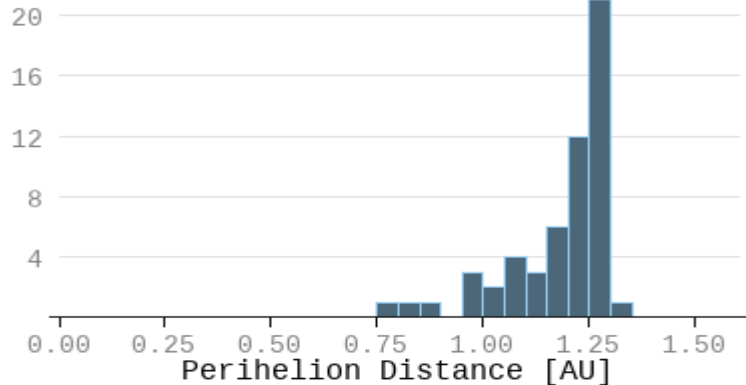
Automated Search in the Isolated Tracklet File (ITF)

- Search every day, check each new ITF tracklet for curvature
 - Underway for well over a year, receive automated alerts
 - Candidate found every ~two weeks at low threshold
 - But the vast majority of PS cases are rejected ...
 - ... after astrometric re-measurements including uncertainties
 - Sometimes corrupted detections
 - Otherwise post to the NEOCP and (hopefully) obtain follow-up
 - 2024 SO₅₄ = CHFMF5Z was identified
 - Confirmed to have obvious curvature, but was not an NEO

P11TUGX

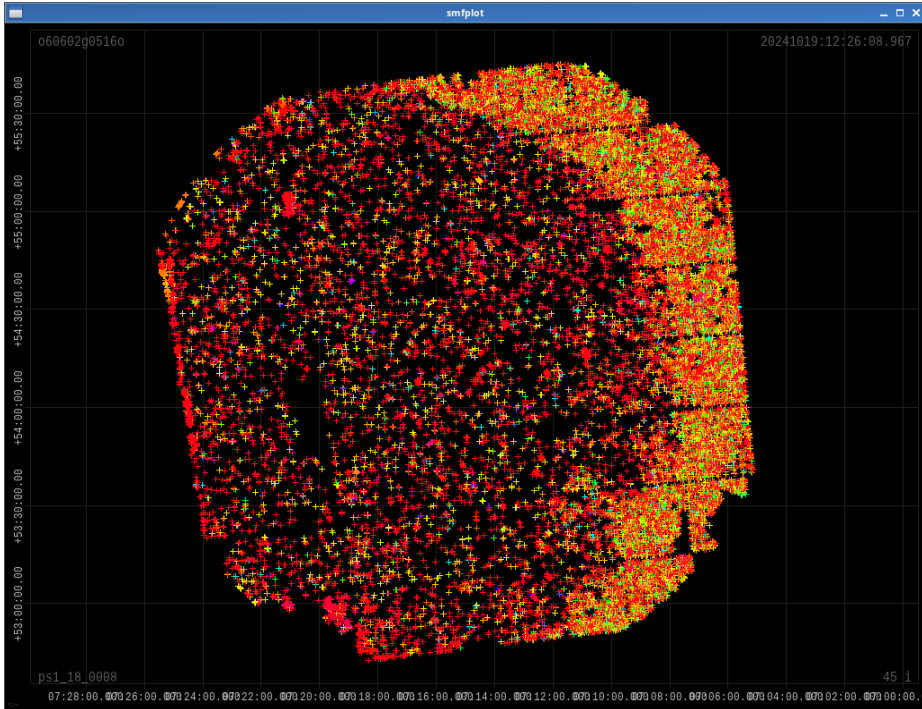
- Motion: ω 0.18°/day, ρ 287°, $V \sim 20.7$
- Dave Bell at the MPC noted via JIRA:
 - “Interesting that the digest is only ~ 6 but the variant orbits on the NEOCP are 96% NEO-like.”
- Fitted $a_{\perp} = 1.575 \pm 0.418$, improved to 1.488 ± 0.041 ...
 - ... after not assuming astrometric uncertainties
- P11TUGX was not confirmed (May 12.71 UT)
 - Best to analyse ITF tracklets soon after they are submitted
 - Need to fully consider astrometric uncertainties

Not many ... But perhaps this is expected ?



- Objects closer to the Earth mostly have larger score anyway
 - Somewhat confirmed by ITF tracklet linking
 - But some bias as curvature inflates the apparent GCRs
- Same night follow-up really is needed to increase discovery rate
 - We do have this capability via CSS, PS, CFHT, ...
 - Also archival detections

Processing 'chip' (non-difference) images

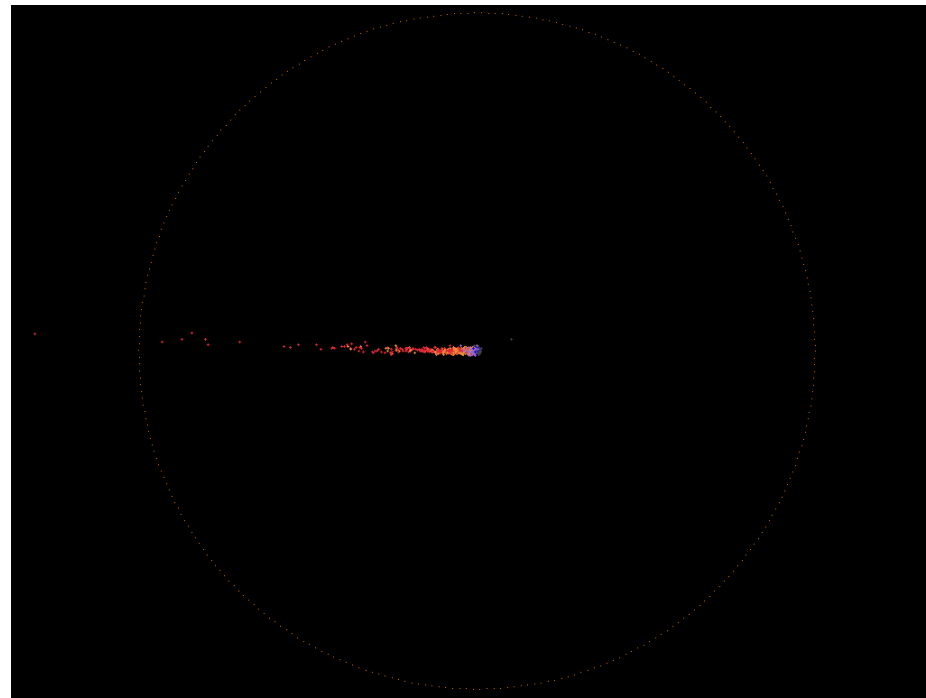
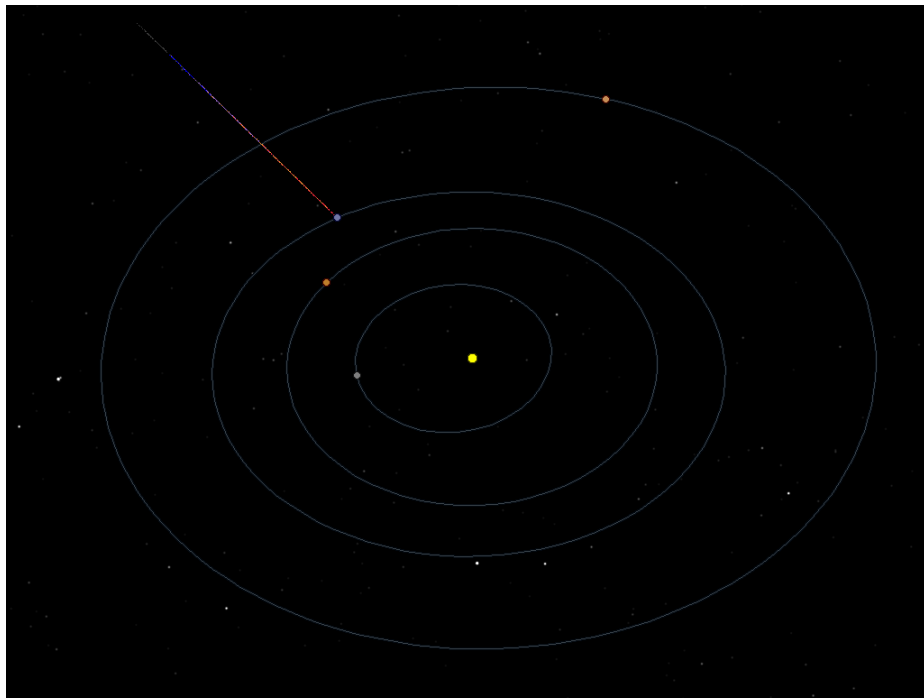


- Stationary objects can be removed using all available w-band images
 - Running for ~two months now
 - Increase in SNR
- Tracklet linking algorithm is made curvature-aware
 - More realistic GCRs
- Slower moving objects
 - 2019 OK for example
 - Hopefully more LPCs too

Initial Results

- Candidate Detections
 - p0003r is on the NEOCP
 - p00043 is on the NEOCP
 - p00044 is on the NEOCP
 - p0004M is on the NEOCP
 - p00038 was not confirmed
 - p0002f was not confirmed
 - p0000i was not confirmed
 - p00002 was not confirmed
- Apollo (recovery)
 - 2022 AK = p0003g
- Centaurs
 - 2025 GG = p0002r
 - 2025 GF = p00034
 - 2025 GE = p0002s
 - 2025 FX₁₉ = p0002A
- Many other low score objects
 - For future ITF linking ...

JPL/Scout Follow-up Prediction - p00044



Summary

- Goal is to increase NEO discoveries by searching for objects which might not otherwise be found due to their low scores
 - Analyse the curvature of tracklets for objects close to Earth
- Two paths for object discovery:
 - Recent submissions in the Isolated Tracklet File (ITF)
 - Pan-STARRS ‘chip’ images (includes slower moving objects)
- Initial work has found a number of Centaurs and an Apollo recovery, otherwise numerous ‘was not confirmed’ cases
 - Need to better distinguish image artefacts and artificial satellites
 - Want to submit to NEOCP sooner to make follow-up easier