Solar System Astrometry

Alexander Carr
What to expect:

1. Introduction to astrometry
   a. Preparation
   b. Operations
   c. Data Reduction

2. Conclusion and Thanks
Asteroid Tracking and NEO Monitoring
ASTEROID OCCULTATION
GEOMETRY

TO STAR

EARTH

ASTEROID

OBSERVERS
Choosing Our Targets

Not enough reference stars

Lots of reference stars!
The 0.6m telescope & dome

Astro-Mechanics, Ritchey-Chretien 0.6m

Reflecting telescope at Table Mountain Observatory.

Finger lakes Instrumentation 4K Camera
Dome Control

Follows telescope throughout the night
Camera control

Set exposure time
Set readout speed
Cooling control
Exposes CCD
LOAD AND ACTIVATE! Telescope Control Program

R.A. (app.)  Dec. (app.)  H.A.  sec (Z)
12:14:08.40  -39:59:59.8  -00:00:00.09  3.714
34:24:00.0  +00:00:00.00  1.000
+74:23:59.8  +00:00:01.3

Date (UT) 8/10/2016  JD (0 hours UT) 2457610.5
UT 22:45:30  LST 12:14:08

Refraction Correction
Automatic  39.4
Use R0 = 50.0
None

HA Slew Rate ("/sec <3600) 3600.0
Dec Slew Rate ("/sec <3600) 3600.0

Activate  Zenith  Stow  A
Calibrate
Record Position
Slewing control
Centering the target
Focus client

Many values of $z$ are tried

Until the focus is correct
The Weather

Temperature

Barometer

Humidity
Sidereal Day vs. Solar Day

- Sidereal day 23 hr 56 min
- Solar day 24 hr
- One sidereal day's motion on the Earth
Asteroid Pallas

RA 21h 32m 49s

DEC +11° 04’
M11 (aql)

The Wild Duck cluster
M11 (aql)

The Wild Duck cluster
Neptune and Triton! Many other planetary satellites (moons)
Just doit!

Reformats picture files (~60 per night)

Does atmospheric refraction calculations

Looks for local brightness maxima

Attempts centerfinding for each asteroid

 Throws out stars/targets that are too faint
Just doit!

Reduce asteroid observations:

Addhan (classifies astronomical seeing)
Trajectory Geometry Program (tgp)
Astrometric Matching Program (amp)
Astrometric Observables and Partials Generator (aopg)
Xrover

Load the picture and the PSF overlay

Shift PSF overlay to match reference stars and asteroid in the actual picture
Xrover

Align the overlay to match the picture
Xrover

Zoom in on the asteroid

Pixel coordinates?

Brightness level?

65535 \( (2^{16} - 1) \)
One last thing: findbad

Bad residual: actual position significantly different than predicted

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Finishing up: Report for each target asteroid

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Residuals

\[ \sqrt{\chi^2} = 1.9592 \]

No residuals found outside 1.
All done? Deliver and Cleanup!

Deliver one file per night to the Minor Planet Center and the occultation team at JPL

Wait for acknowledgment:

To: Owen, William M (392L)
Subject: Acknowledgement

The receipt of a message (probably containing observations) is hereby acknowledged.
Acknowledgements

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Heath Rhoades, JPL

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