Gravitational Microlensing
At Auckland Observatory

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New Zealand
Outline

- Auckland situation
- Equipment and software
- Image calibration and reduction
- Event follow-up
- Issues
0.4m Meade-ACF
Dew heater

Paramount GT1100s

*Minimal periodic error*  
(*<0.5as*)
**TPoint**

Improves absolute pointing and tracking
Major Hardware

- Paramount GT1100s mount *(ASB Trust)*
- Meade-ACF 0.40m f/10 (2006) *(Sth Auckland Trust)*
- Optec TCF-S focuser *(MicroFUN)*
- Optec filter wheel (Schott OG530 filter) *(MicroFUN)*
- Apogee AP8p CCD with 24 μm pixels (1.2as) *(ASB Trust)*
- SBIG ST7XME with 9μm pixels (0.46as) (2007/08) *(MAGS)*
- Boltwood Cloud Sensor *(MicroFUN)*

Major Software

- The Sky v6 - with TPoint
- MaxIm DL/CCD v4
Schott OG530
(#12 Kodak Wratten)
Optec filter wheel:
BVRI + Schott OG530

Optec TCF-S focuser
Temperature compensating

Apogee AP8p CCD Camera
1kx1k 24μm pixels
Scale: 1.2as/pixel
Image Calibration

- Record bias at regular intervals (~1950ADU)
- Expose science frame (1-5mins)
- Subtract median bias (n=20) from image
- Subtract scaled dark (~20hr) from image
- Divide image by flat field frame
- We only use twilight sky flats
Photometric Reductions

- Aperture photometry “at the telescope”
- OSU pipeline uses DoPhot (PSF fitting)
- OGLE & MOA pipelines use image subtraction (DIA) which is close to optimal for information extraction
- Inter-site calibration. Need to match to I-band for different detectors and filters
OSU Dophot reduction (n=521)
0.4m Meade-ACF/ST7XME

![Graph showing FWHM (arc-sec) distribution with frequency on the y-axis and FWHM on the x-axis. The data points are represented by blue squares and connected by a blue line. The graph is labeled with the title and the data points for frequency and FWHM.](image)
Locating an object

- Add coordinates to “The Sky”
- Slew to this object (~60as RMS)
- Expose a 10s image in MaximDL
- Copy/Paste image into “The Sky”
- Astrometrically align to field stars (Image Link)
- Object will now be marked on the image
- Re-centre on target
- Make a positive ID from OGLE image
### Summary of Microlensing Events Observed

<table>
<thead>
<tr>
<th>Year</th>
<th>Events</th>
<th>Observing Time (Hours)</th>
<th>Planets</th>
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</thead>
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<td>2003</td>
<td>4</td>
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</table>
Operational Requirements

• Southern latitude preferred
  
  **Declination: -30°**

• Aperture >0.2m

• Image scale with FWHM 2-3 pixels

• Good tracking for 2-5 mins

• Broadband Internet access
Auckland Issues

- CCD camera – 9μm pixels
- Dome automation

MicroFUN Issues

- Filters – help or hinderance?
- What to do about bad pixels
- Local photometry pipelines
Summary

• Small telescopes can be surprisingly effective
• They are common, can re-schedule targets at short notice and dedicate 100% of time
• Redundancy defeats weather and provides corroboration
• Good collimation, focus, tracking and calibration are needed
• MicroFUN is a textbook example of pro-am collaboration