OGLE Data Management

_from mega to terabytes_

Michał Szymański
Astronomical Observatory, University of Warsaw
OGLE-BLG-LPV-110492

- GB1 16266
- BUL_SC4 92723
- BLG101.3 103764
- BLG501.18 5933

JD-2450000

I

Warsaw 24-28 July 2017

OGLE data management

Michał Szymański
- time span: 8246 days, 22.5 years, 15918 epochs
- 255 GB of FITS (sub)images
- 20 GB of photometry databases
# Some numbers

<table>
<thead>
<tr>
<th>OGLE</th>
<th>Main targets</th>
<th>Nights GB/n. TB/y.</th>
<th>Frames MB/fr.</th>
<th>Area sq.deg</th>
<th>Stars (10^6)</th>
<th>Data (TB)</th>
<th>Epochs (10^9)</th>
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<tbody>
<tr>
<td>I 1992-1995</td>
<td>GB, GC galaxies</td>
<td>295 0.25 0.09</td>
<td>9800 8</td>
<td>1.5</td>
<td>6</td>
<td>0.078</td>
<td>0.7</td>
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<tr>
<td>II 1996-2001</td>
<td>GB, GD LMC SMC</td>
<td>1080 1.2 0.4</td>
<td>39000 32</td>
<td>27</td>
<td>44</td>
<td>1.2</td>
<td>13</td>
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<tr>
<td>III 2001-2009</td>
<td>GB, GD LMC SMC</td>
<td>2900 10.5 3.8</td>
<td>235000 128(8*16)</td>
<td>170</td>
<td>389</td>
<td>30</td>
<td>183</td>
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<tr>
<td>IV 2010-</td>
<td>GB, GD MC MBR</td>
<td>2700 100 36</td>
<td>500000 512(32*16)</td>
<td>3500</td>
<td>863+</td>
<td>256</td>
<td>800+</td>
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</table>
# Some ratios

<table>
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<th>OGLE</th>
<th>Main targets</th>
<th>Nights GB/n.</th>
<th>Frames MB/fr.</th>
<th>Area sq.deg</th>
<th>Stars (10^6)</th>
<th>Data (TB)</th>
<th>Epochs (10^9)</th>
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<tr>
<td>IV</td>
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<td>9.2</td>
<td>51</td>
<td>2300</td>
<td>150+</td>
<td>3300</td>
<td>1100+</td>
</tr>
</tbody>
</table>
O-I central field BWC – 254491 stars
O-IV most dense field – 7066461 stars
O-IV least dense field – 21333 stars
Data acquisition and analysis

- at the telescope (LCO):
  - acquisition
  - de-biasing, flat-fielding
  - near real-time photometry
  - alert systems: EWS, EEWS, Transients etc.

- in Warsaw:
  - full scientific analysis
  - archiving
  - public access (catalogs, photometry)
Data acquisition

'charon' PC
C/A

CCD camera

'ogle' PC
C/A/Ar

'ulens' PC
R/Ar

PC (R) PC (R) PC (R)

C – control
A – acquisition
Ar – archiving
R – reductions
Data reduction pipeline

- **NIGHT, near-real time**
  - new image on ‘ogle’, every 45-150 sec
  - flatdaemon on ‘ulens’ – up to 6 instances
  - ~120 framedaemons on ‘blade PCs’
  - alert daemons (EEWS, transients)

- **DAYTIME**
  - adding photometry to databases
  - EWS
  - archiving
OGLE CPU power in LCO

- OGLE-I, -II, -III
  - Sun Sparcstations 1, 2, 10, 20; various PCs
- OGLE-III
  - 4 2xCPU PCs, Xeon 3.06GHz 4GB RAM (~2004)
- OGLE-IV
  - 6 2xCPU, 4core Xeon E5450 3GHz 32GB RAM
  - 2 24x1TB storage servers (‘ogle’, ‘ulens’)
  - since 2014:
    - 2 5TB storage blades plus 5 twin blades
      128/64GB RAM + 2xE5-2480v2 CPU (240 cores!)
    - 24x4TB storage server (‘ulens’)

OGLE data management
Michał Szymański
OGLE-IV 2010-2013

computer resources in LCO

Total of:

64 cores
50 TB storage space

interconnected with 1/10 Gbit ethernet
OGLE-IV 2014-
computer resources in LCO

Total of:
260 cores in high-end CPUs
120 TB storage space
interconnected with
10 Gbit ethernet
OGLE CPU power in Warsaw

Dedicated server room:
- 18 storage servers:
  - 240 high-end CPU cores
  - 1 TB RAM
  - 840 TB storage space
- 76 blade number crunchers:
  - 1352 high-end CPU cores
  - 4.3 TB RAM
  - 47 TB storage space
Warsaw server room
Troubleshooting

- HDD failures
- RAID failures
  - August, 2014
Troubleshooting

- HDD failures
- RAID failures
  - August, 2014
- Mice
  - Chilean equivalent of the second Plague of Egypt
Desierto florido
Desierto florido
2001 – telescope control boards
2016 – data acquisition fiber
2016 – temporary overhead fiber
2016 – replacement fiber
Storing results for analysis

- **LCO:**
  - photometry results + DIA subtracted images
  - current databases (827GB as of Jul 23)
  - recent images (RAW & calibrated)

- **Warsaw**
  - results (copied from LCO)
  - sequential databases
  - all images on tapes
  - calibrated images also on-line
Storing results for analysis

Photometry databases:

- frames info
- template objects (coords, photometry)
- new objects (frames, coords, photometry)

- OGLE-I 4 GB
- OGLE-II 90 GB
- OGLE-III 915 GB
- OGLE-IV 3.7 TB (2010-2016)
Data archiving/transfer

- **Tapes**
  - OGLE-I: Exabyte (Data 8mm, 2.5/5GB),
  - OGLE-II: DLT (20/40GB)
  - OGLE-III:
    - Ultrium LTO-1/2 (100, 200GB)
  - OGLE-IV:
    - Ultrium LTO-3/4/5/6 (400/800GB/1.5/2.5TB)

- **Online storage**
  - FITS images
  - Results
Data archiving/transfer
Datasets publicly available

- OGLE-II
  - catalogs of objects of various types
  - photometric maps
  - full photometry access

- OGLE-III
  - Catalog of Variable Stars (CVS)
  - photometric maps

- OGLE-IV
  - OGLE Collection of Variable Stars (OCVS)

http://ogle.astrouw.edu.pl

OGLE data management
Michał Szymański
**OGLE-II Photometry Web Access**

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### OGLE Photometry Database Query Page

Select OGLE target:
- [ ] Galactic Bulge
- [ ] Galactic Disk
- [ ] LMC
- [ ] SMC

Select parameters database:
- [ ] OGLE-II I-band PSF (DoPHOT) photometry
- [ ] OGLE-II I-band DIA photometry

Enter values or ranges of parameters, check appropriate **Use** boxes (Uncheck **Query** box below):

<table>
<thead>
<tr>
<th>Show</th>
<th>Sort</th>
<th>Parameter</th>
<th>Use</th>
<th>Value/Range</th>
<th>Description</th>
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<tbody>
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<td>Decl</td>
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<td>Declination (J2000) ¹</td>
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<td>Mean I-magnitude ²</td>
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<td>Median I-magnitude ²</td>
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<td>Standard deviation of I-magnitude ²</td>
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<td>Median error of I-magnitude ²</td>
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<tr>
<td></td>
<td></td>
<td>Ndetect</td>
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<td></td>
<td>No. of detections on subtracted image (DIA only)</td>
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</tbody>
</table>

¹ RA/Dec, X/Y may also specify a circle or rectangle centered on a point, see Query Help for details; RA format: HH:MM:SS or HHHHH, Decl: ±DD:MM:SS or ±D.DDDDD

² of good points (if Ngood>0)

Enter SQL query using the above parameter names (Check **Query** box below):

- [ ] Query: SELECT objects FROM db WHERE

Sort: [ ] ascending [ ] descending  [ ] No catalog flag objects only  [ ] Hexag. RA/Dec output

Check **Show** boxes above for the parameters to display, 50 objects per page, max of 1000 objects

Note: Depending on the target and query it may take a while to complete.
### OGLE-II Photometry Web Access

**Phot Query:** SELECT FROM smc2dia WHERE \( \text{I} \leq 14 \) and \( \text{Isig} \geq 0.4 \)

Displaying Page 1 of 1: objects 1-16 of 16

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<tr>
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<th>StarCat</th>
<th>RA</th>
<th>Decl</th>
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<th>I</th>
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</table>
OGLE-II Photometry Web Access

OGLE-II DIA Photometry
Field: SMC_SC5 StarID: 111430

Download: object photometry PS light curve

smc_sc5_i_111430

500 1000 1500
12 13 14 15

2450466.53924 14.262 0.003 40 B
2450466.54834 14.263 0.003 40 C
2450466.56358 14.253 0.003 40 D
2450466.59417 14.270 0.003 40 C
2450466.62371 14.257 0.003 40 B
2450467.54156 14.276 0.003 40 C
OCVS Web Access
OCVS Web Access
OCVS Web Access

OGLE Collection of Variable Stars

Welcome page
News/Changes

Database Queries:
Classical Cepheids
Anomalous Cepheids
Eclipsing Stars

Query Help

OGLE-IV Photometry of OGLE-LMC-CEP-2949

RA/Decl (J2000): 5h 41m 45.54s -68d 41m 16.1s

Identification: OGLE-III: LMC182.7.12; OGLE-IV: LMC554.05.3; OTHER: HV2793

I = 13.167 V = 14.125
P_1 = 19.2261771 \phi_1 = 0.0002070 \phi_0 = 0.1010.1255 A_1 = 0.389 R21_1 = 0.207 p221_1 = 4.977 R31_1 = 0.210 p231_1 = 2.236

Download:
object L-band V-band photometry Finding chart
PS lightcurve phased with P_1 All data

OGLE-LMC-CEP-2949

I-band
H2O-2450000 mag err
5265.66360 12.948 0.005 5265.51347 14.351 0.004
5264.42837 12.988 0.005 5265.55342 14.366 0.004
5265.62205 13.647 0.005 5447.09508 14.488 0.005
5266.42905 13.606 0.005 5445.09232 14.234 0.004
5267.63503 13.157 0.005 5447.08783 14.374 0.005
5268.6319 12.304 0.005 5445.08139 14.379 0.005
5269.58367 13.201 0.005 5443.04271 13.654 0.005
5270.58558 13.371 0.005 5442.12561 13.541 0.005
5271.75839 13.431 0.005 5448.97539 14.318 0.005
5272.5841 14.567 0.005 5450.77097 14.373 0.005
5273.61272 12.430 0.005 5502.87092 14.427 0.005
5274.62930 12.387 0.005 5506.04160 14.069 0.005
5275.5303 12.902 0.005 5508.77400 14.421 0.005
5276.57684 12.552 0.005 5507.01384 14.275 0.005
5277.59840 12.195 0.005 5510.81382 14.371 0.005
5282.56832 12.075 0.005 5511.00819 14.727 0.005
5283.86285 12.067 0.005 5521.16490 15.068 0.005
5284.55693 12.086 0.005 5521.78352 15.597 0.005
5285.49927 13.138 0.005 5522.76187 15.064 0.005
5286.42499 13.064 0.005 5527.72402 14.425 0.005
5287.52514 13.233 0.005 5532.15826 14.478 0.005
5288.57243 13.124 0.005 5534.71837 14.316 0.005
5289.54783 13.244 0.005 5532.71783 14.316 0.005

V-band
H2O-2450000 mag err
5265.66360 12.948 0.005 5265.51347 14.351 0.004
5264.42837 12.988 0.005 5265.55342 14.366 0.004
5265.62205 13.647 0.005 5447.09508 14.488 0.005
5266.42905 13.606 0.005 5445.09232 14.234 0.004
5267.63503 13.157 0.005 5447.08783 14.374 0.005
5268.6319 12.304 0.005 5445.08139 14.379 0.005
5269.58367 13.201 0.005 5443.04271 13.654 0.005
5270.58558 13.371 0.005 5442.12561 13.541 0.005
5271.75839 13.431 0.005 5448.97539 14.318 0.005
5272.5841 14.567 0.005 5450.77097 14.373 0.005
5273.61272 12.430 0.005 5502.87092 14.427 0.005
5274.62930 12.387 0.005 5506.04160 14.069 0.005
5275.5303 12.902 0.005 5508.77400 14.421 0.005
5276.57684 12.552 0.005 5507.01384 14.275 0.005
5277.59840 12.195 0.005 5510.81382 14.371 0.005
5282.56832 12.075 0.005 5511.00819 14.727 0.005
5283.86285 12.067 0.005 5521.16490 15.068 0.005
5284.55693 12.086 0.005 5521.78352 15.597 0.005
5285.49927 13.138 0.005 5522.76187 15.064 0.005
5286.42499 13.064 0.005 5532.15826 14.478 0.005
5287.52514 13.233 0.005 5534.71837 14.316 0.005
5288.54783 13.244 0.005 5532.71783 14.316 0.005

Finding chart (60x60 arcsec)
Datasets yet to be published

- OGLE-III
  - full photometry access (soon)

- OGLE-IV
  - photometric maps (soon)
  - full photometry access (surely not soon)
From mega to terabytes: Conclusion

- Single OGLE-I image was 8MB
- Total volume of OGLE data kept in tape archives and on-line
  - RAW and calibrated images
  - Results
  - Databases

has reached ~700 TB
From mega to terabytes: Conclusion

- Single OGLE-I image was 8MB
- Total volume of OGLE data kept in tape archives and on-line
  - RAW and calibrated images
  - Results
  - Databases
  has reached ~700 TB
- If I had been paid just 1¢ for every MB, I would have become a multi-millionaire
From mega to terabytes: Conclusion

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  - has reached ~700 TB
- If I had been paid just 1¢ for every MB, I would have become a multi-millionaire
- Yet, is was worth doing, every mega/giga/terabyte!
OGLE Data Management

*from mega to terabytes*

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