Creating variable star catalogs from public photographic plate archives

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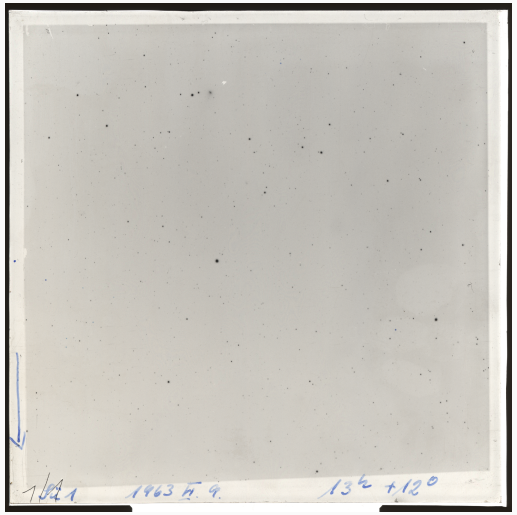
Research topic for my PhD

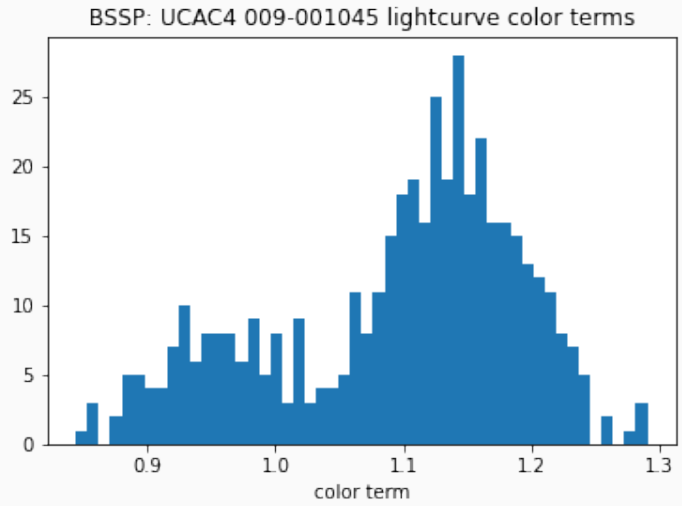


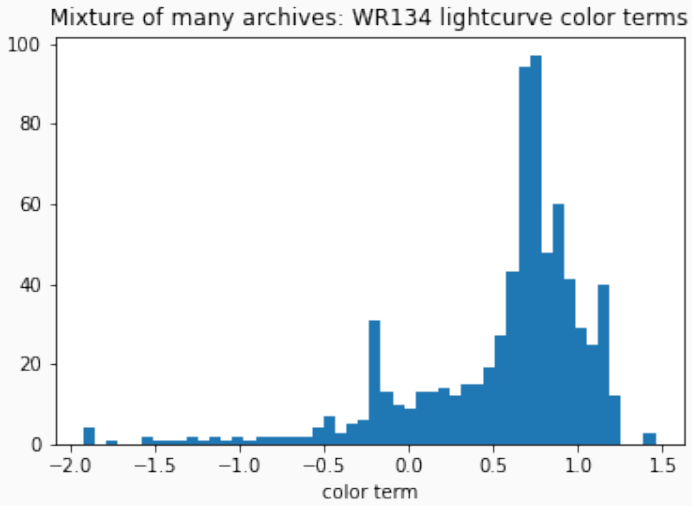
- Analysis of photographic plate archives
- Focused on (semi-) periodic variable stars
- Goal: Produce catalogs of variable stars to study aspects like period changes and long termin variability

Bamberg Southern Sky Patrol (BSSP)

- Photographic plate survey at southern sky
- Carried out between 1962 and 1976
- Boyden Observatory (South Africa)
- Mount John (New Zeeland)
- San Miguel Observatory (Argentina)
- 22671 plates in APPLAUSE data release 3

Why not all plates in APPLAUSE?



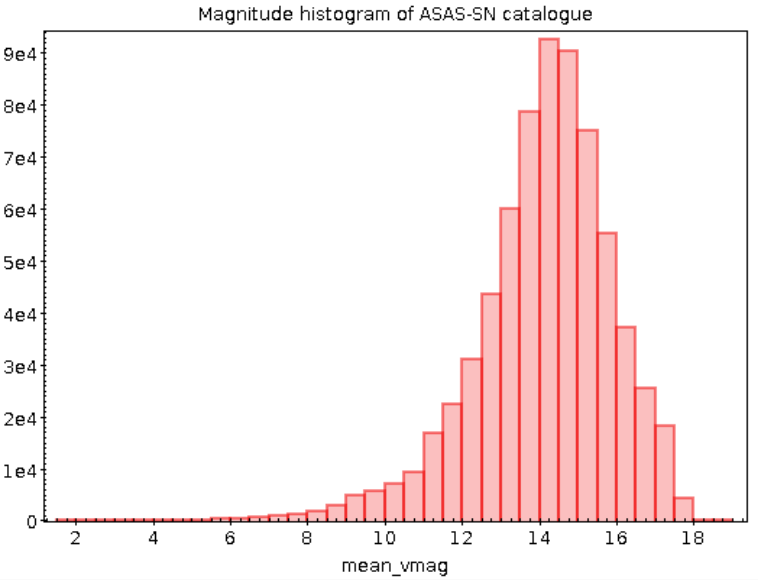


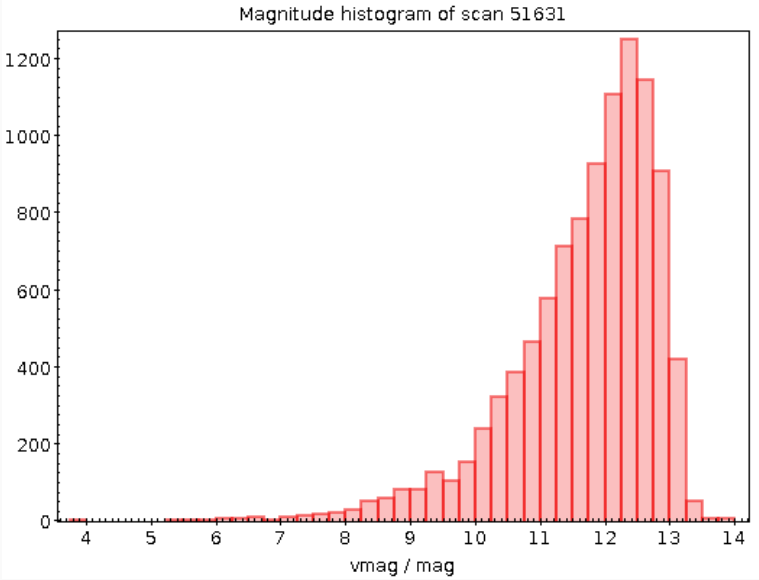
- BSSP plates quite homogenious (only few emulsions)
- In contrast: WR134 (star in cygnus constellation) not covered by BSSP:
  - plates from multiple archives, even more different emulsions
  - color term of data points spreads quite wide due to different emulsions
  - leads to shifts in calibration, resulting in issues in period calculations

ASAS-SN

- All-Sky Automated Survey for Supernovae
- photometric all sky survey running since 2014
- variable star database
- detailed analysis in papers *The ASAS-SN catalogue of variable stars I-IX*
- perfect for comparison with analysis of BSSP variable stars

Comparison of catalog parameters



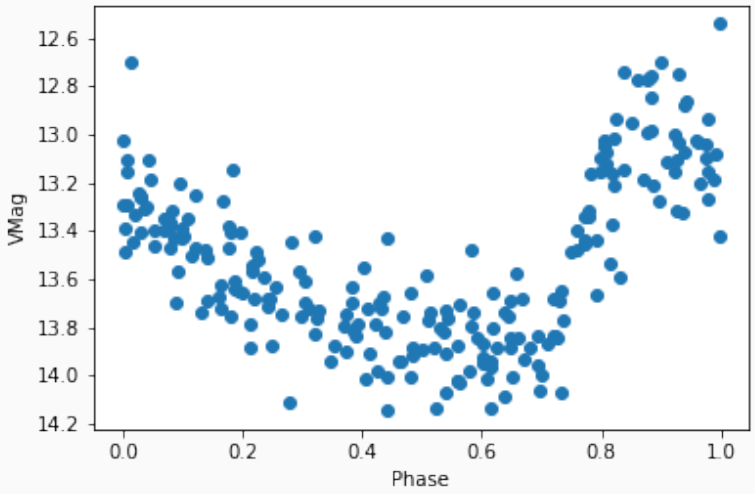


- Criteria for catalog selection
  - Magnitude range (e.g. Gaia problematic for bright objects)
  - Spectral range should match roughly
  - resolution (ASAS-SN: 8 arcsec/pixel, close to BSSP). Gaia resolves much better $\rightarrow$ Sometimes one source in BSSP corresponds to a set of multiple fainter sources in Gaia

Analysis

- crossmatch ASAS-SN with UCAC4 (as this is the best identifier for APPLAUSE)
- get corresponding BSSP lightcurves from APPLAUSE
- perform time series analysis (periods, fourier decomposition)
- try to classify the stars and compare with ASAS-SN

Results



- accurate periods even for noisy stars down to ~14.5 mag
- tested with "stable" variables, esp. RR-Lyrae, periods match ASAS-SN periods by 1.6 seconds (mean difference)
- scientific result for RR-Lyrae: some stars have a significant period difference of tens of seconds to few minutes
- $\rightarrow$ systematic analysis of BSSP will provide a wider range of time series to analyze such effects
- Paper in prepreration, data to be published (via VO)

CenturyOfSky@home I

- Right now: analysis by comparison with known catalogs, search for significant periods using mostly Lomb Scargle (LS) algorithm
- In many cases, supersmoother algorithm finds periods for different types of variability most reliably when LS fails
- Issue: supersmoother is very expensive with respect to computation time, known variables are only a subset of all stars in BSSP
- Idea: Use the power if distributed computing (DC)!
- **CenturyOfSky@home**
- Also: make photographic plate archives more popular
- BOINC, approach similar to Einstein@home, Universe@home

CenturyOfSky@home II

- Rechenkraft.net: association for distributed computing in germany
- provides infrastructure for DC projects based on BOINC
- will host the project, already hosts some projects, e.g. RNAWorld

Conclusion

- comparative analysis between BSSP and ASAS-SN shows: creating a catalog of variable stars from photographic plate archives provides reliable and even new scientific results
- done for periodic variables such as RR-Lyrae, Mirae etc.
- still missing: irregular variables
- CenturyOfSky@home: proposed citizen science project to provide a way to analyze protographic plate archives

Questions

Thank you very much for your attention!

Questions?

Acknowledgement

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Resources

- APPLAUSE: https://www.plate-archive.org/applause/
- ASAS-SN: https://asas-sn.osu.edu/
- Rechenkraft: https://www.rechenkraft.net/