



Variable Stars as Galactic Probes

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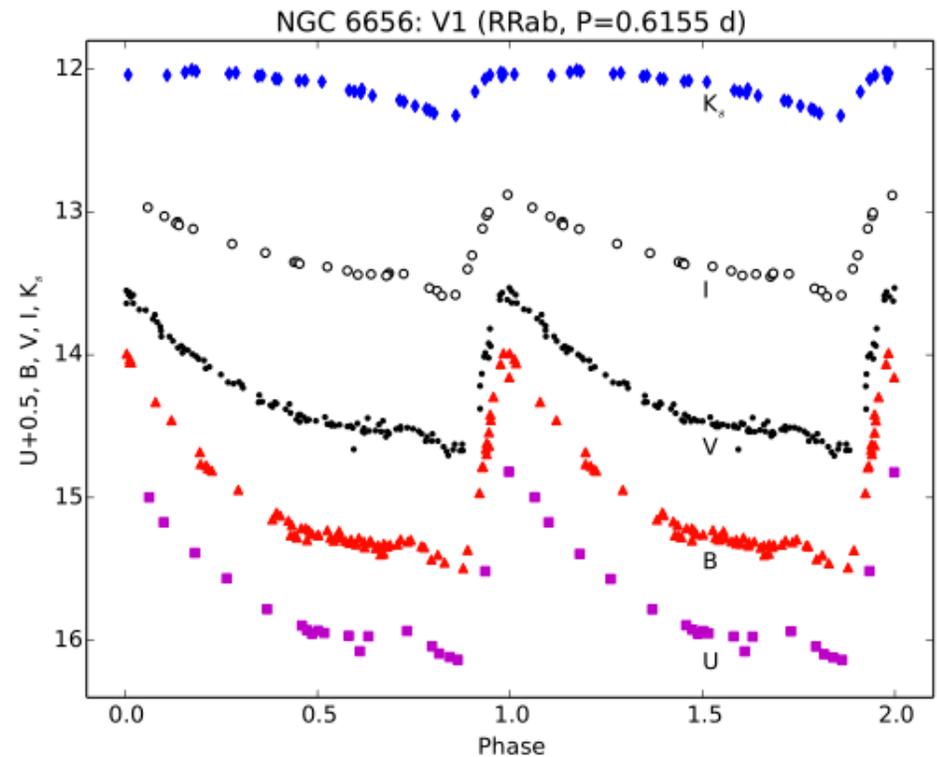
Apache Point Observatory/NMSU

17 November 2014



Utility of Variable stars

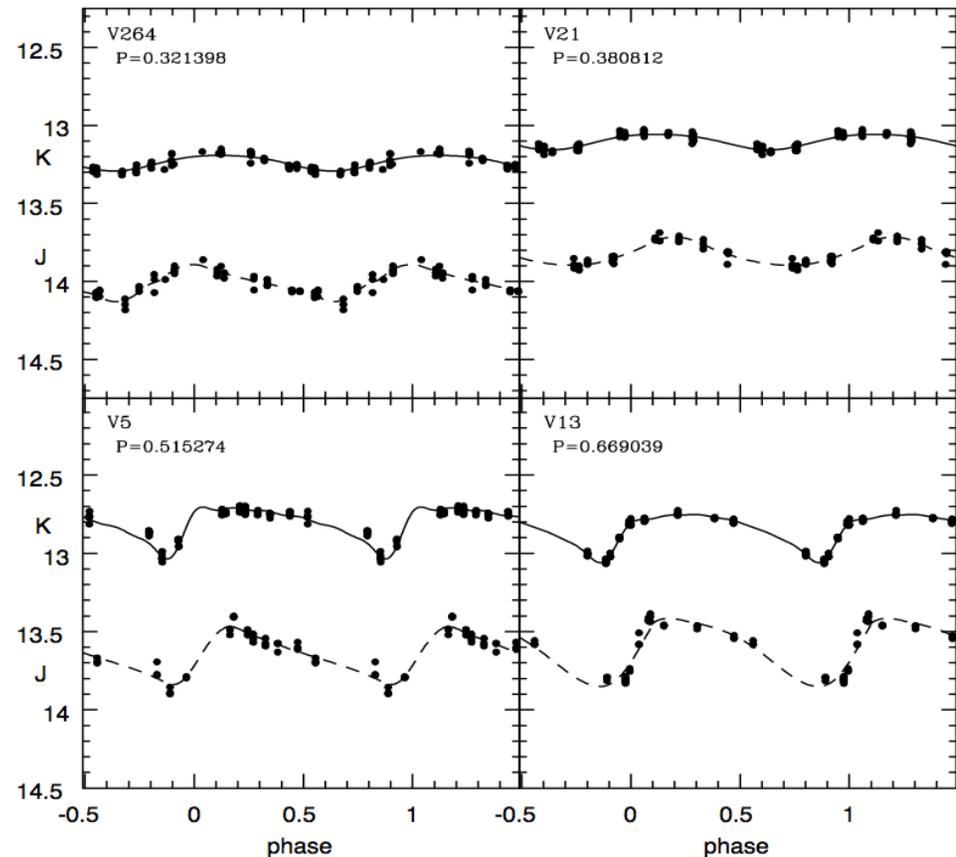
- Easily identifiable in photometric surveys with time-series data collection
- Distance indicators
 - Period-luminosity relation
- Properties of variable stars tell us something of the parent environment (e.g. Galaxy assembly)



Angeloni et al. 2014

How to identify the variable stars

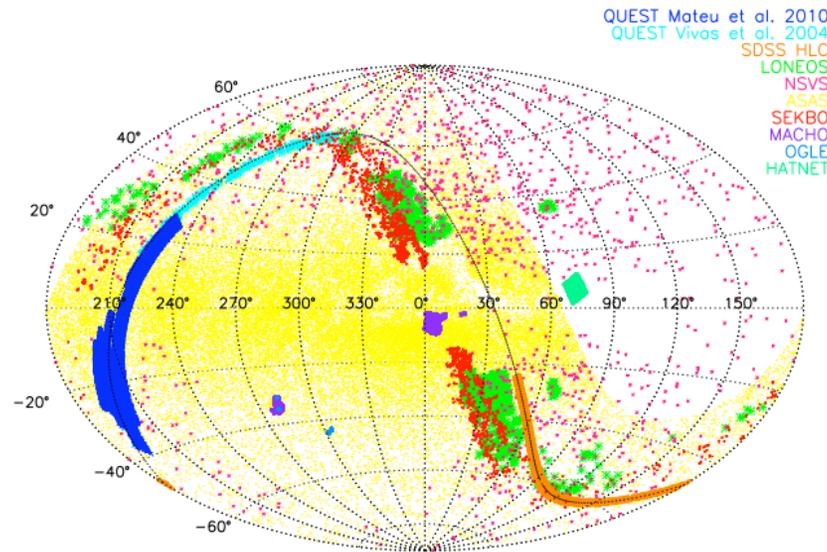
- WFIRST cadence: not as high precision as *Kepler*
- Repeat visits will be a must – similar to Type Ia SN studies
- Light curve templates will help identify variable type (e.g. VVV Template Project – Angeloni et al. 2014)



Del Principe et al. 2006

RR Lyrae stars

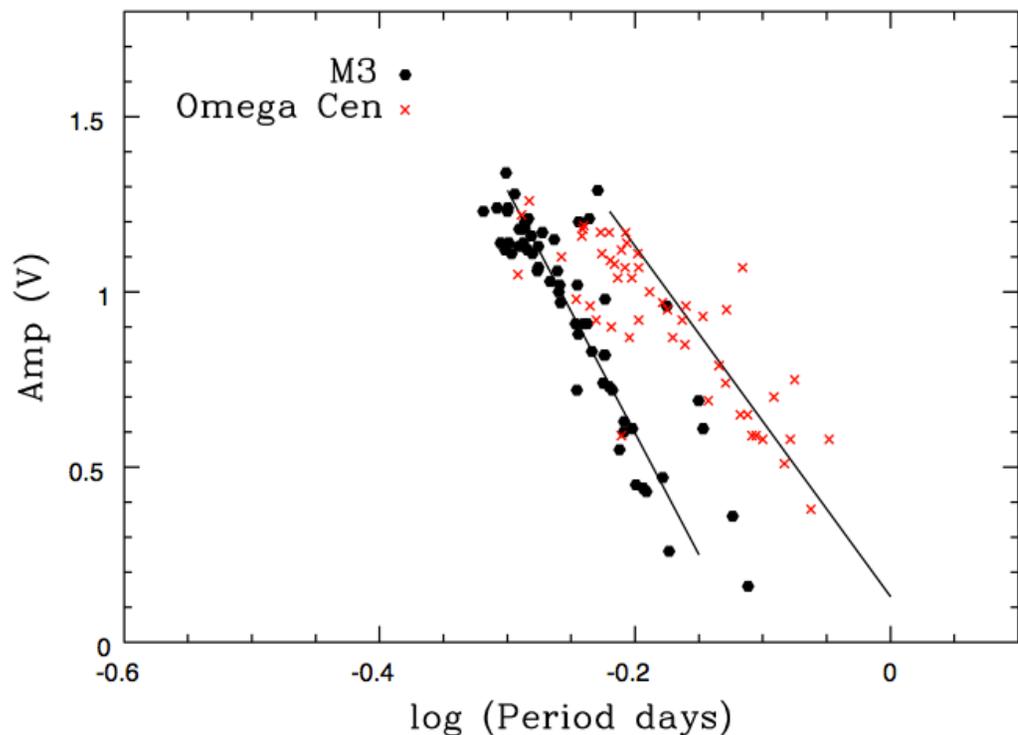
- Pulsating, Population II
- Metal-poor ($\langle [Fe/H] \rangle = -1.55$)
- Relatively short period (between 0.2-1.4 days)
- Found in all Galactic components, globular clusters, Local group dwarf spheroidal galaxies and M31
- Used as luminous tracers of the Milky Way



Mateu et al. 2011

RR Lyrae: Oosterhoff Phenomenon

- Oosterhoff (1939): “dichotomy” of RR Lyrae parameters in GC
 - Period-amplitude diagrams
 - Relative number of RRL subtypes
 - [Fe/H] metallicity (Arp 1955)
 - Space motion (Lee & Carney 1999)



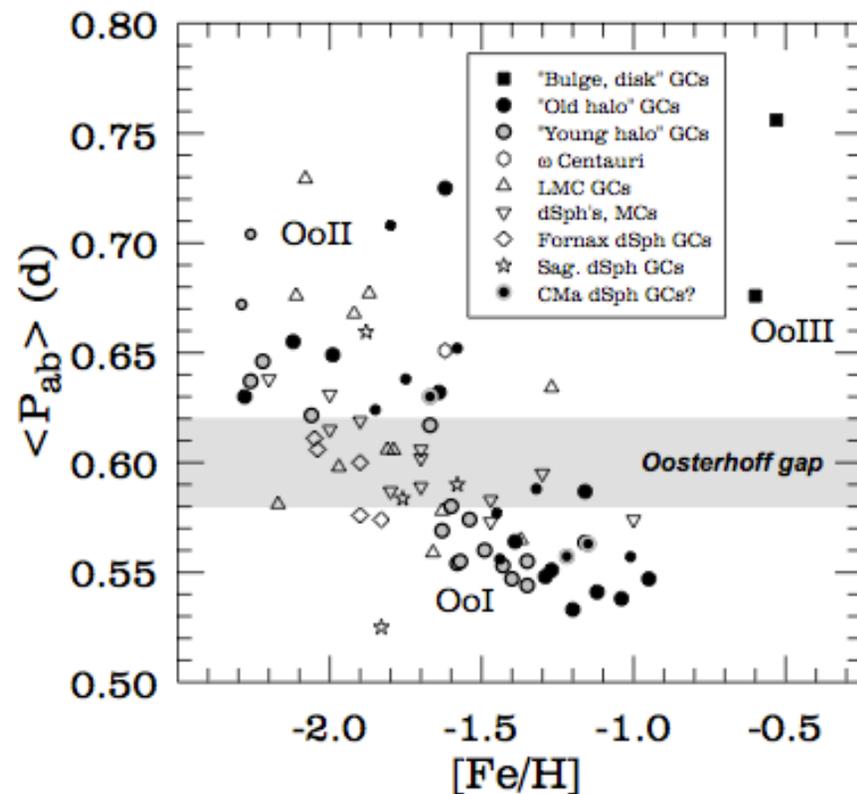
Smith, Catelan & Kuehn 2011

Oosterhoff Classes:

- Oosterhoff I (e.g. M3)
- Oosterhoff II (e.g. Omega Cen)
- Oosterhoff-Intermediate (e.g. dSph)

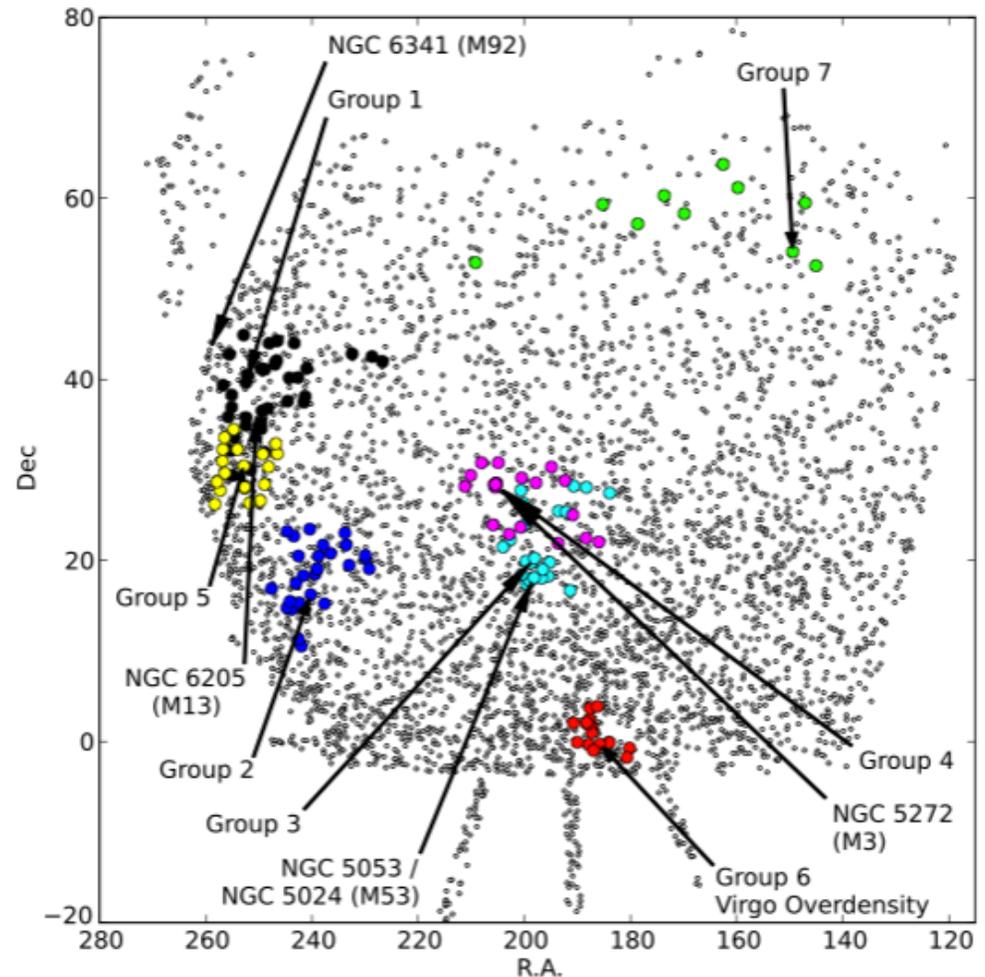
Oosterhoff: dSph galaxies and GCs

- Do we see it in other entities?
 - M31 halo – yes!
 - Local group dwarf galaxies – yes/no
 - MW field population – yes!
- Do we see evidence/support for certain formation scenarios?
 - Can infer Galactic assembly scenario just from RR Lyrae properties
 - Halo RRL properties do not match RRL of dSph



WFIRST and RRL

- NIR: use templates to identify RRL when there are too few points
- NIR: use period-luminosity relation to derive distances
- Scan entire dwarf galaxies
- Scan tidal streams and debris tails in Galactic halo

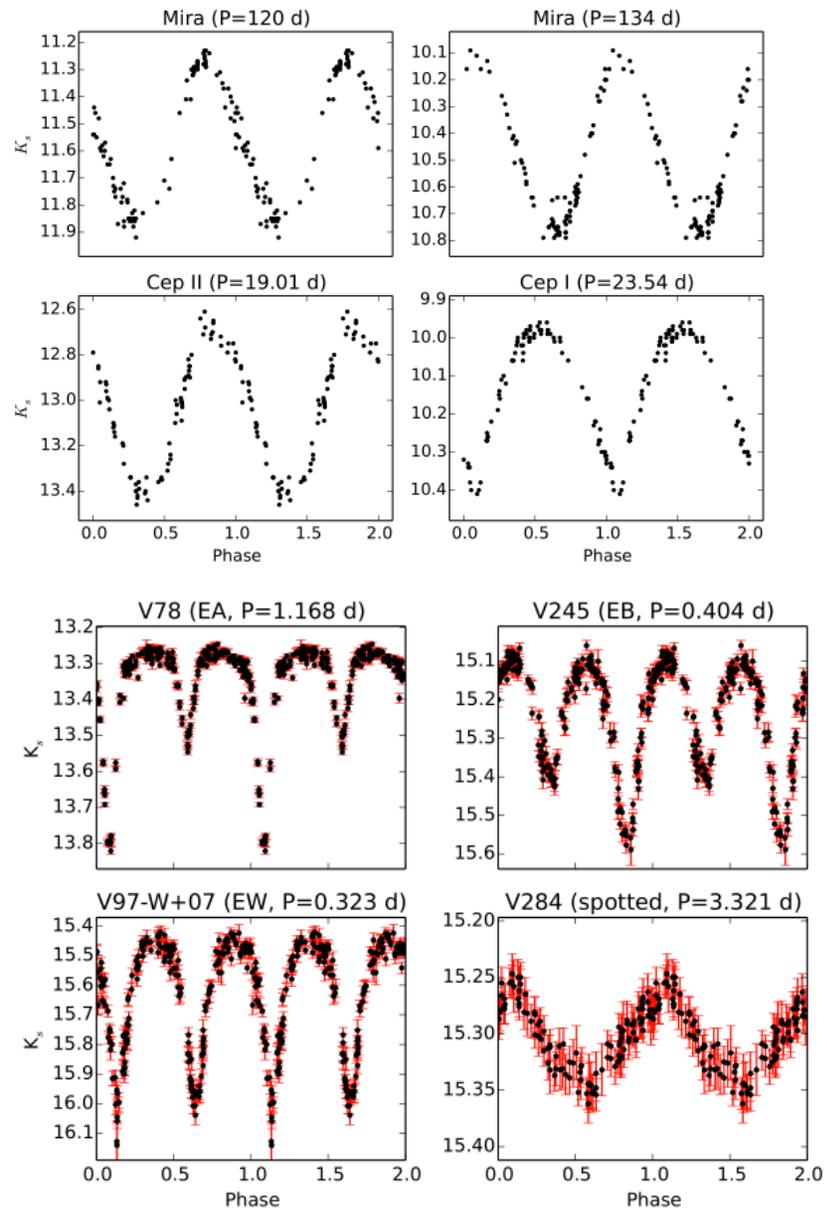


Sesar et al. 2013

Other variable stars

- Cepheids: also distance indicators; longer period than RR Lyrae
- Miras: distance indicators; very long period (100s days)
- Eclipsing binaries: masses, radii, etc
- Depending on the cadence of WFIRST – discovery of other, possibly exotic stars (as in the case of *Kepler*)

Angeloni et al. 2014



Variable stars as yardsticks

- Galactic science goals of WFIRST
 - Constrain galaxy formation scenarios/
hierarchical assembly
 - Address missing satellites question
 - Discover new tidal or subgalactic
structures in the MW halo

