

RR Lyrae Period-Amplitude Diagrams from Bailey to Today

Horace Smith

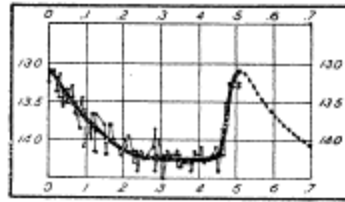
Marcio Catelan

Charles Kuehn

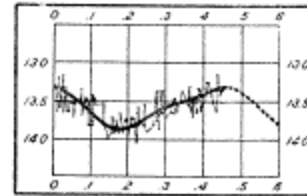
Solon I Bailey



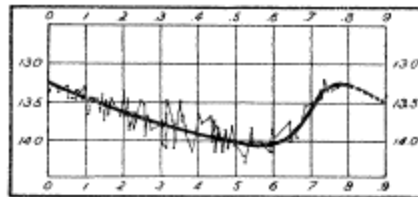
“Cluster variables” in Omega Cen



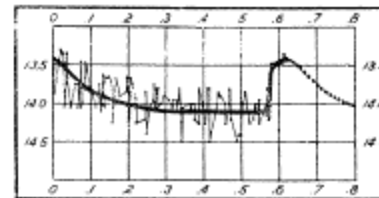
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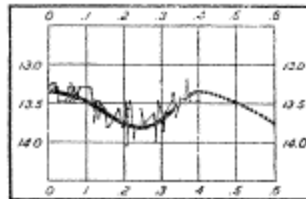
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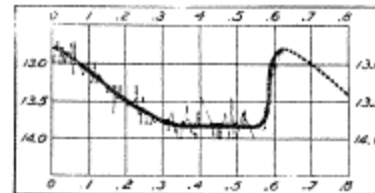
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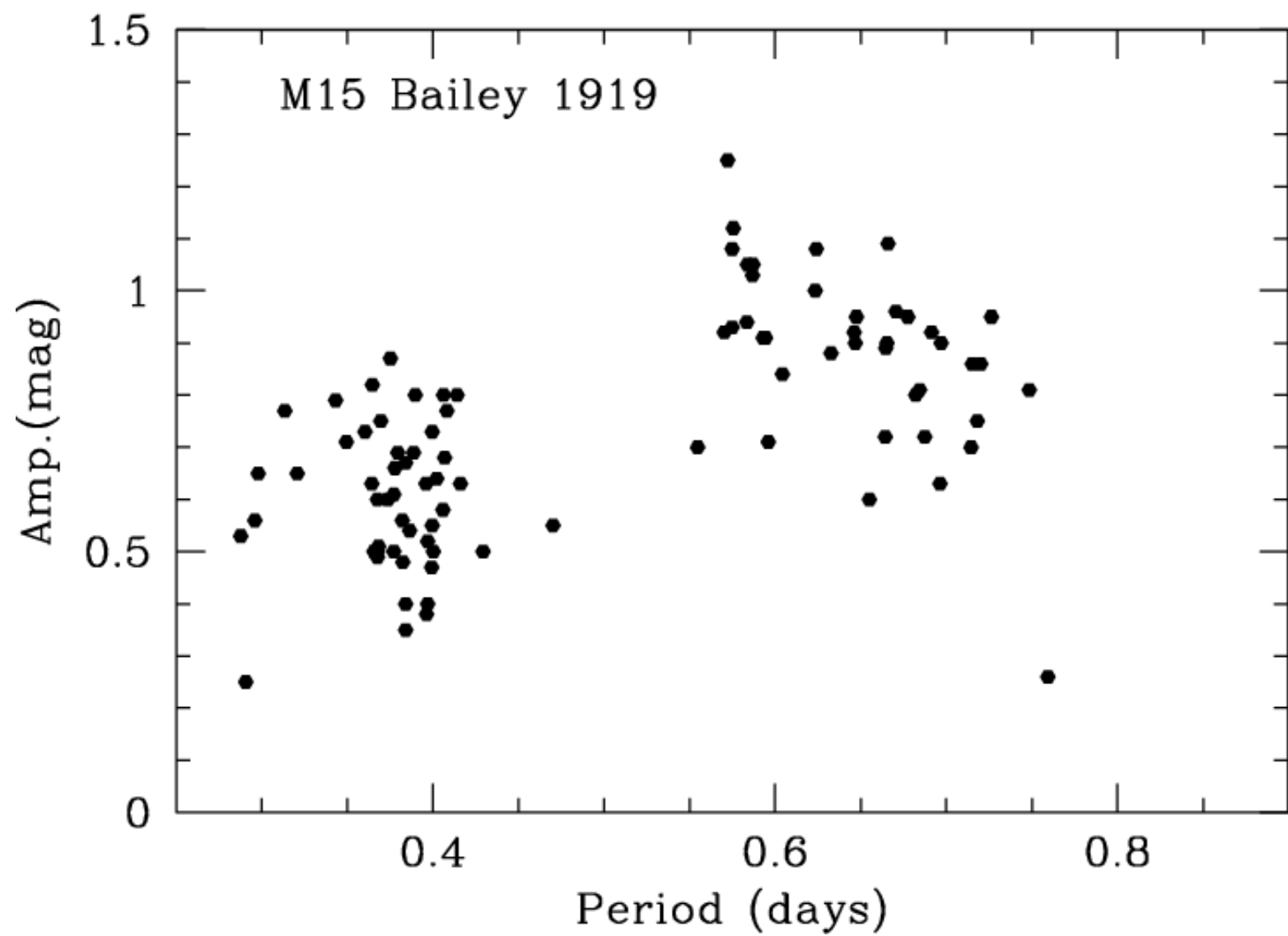


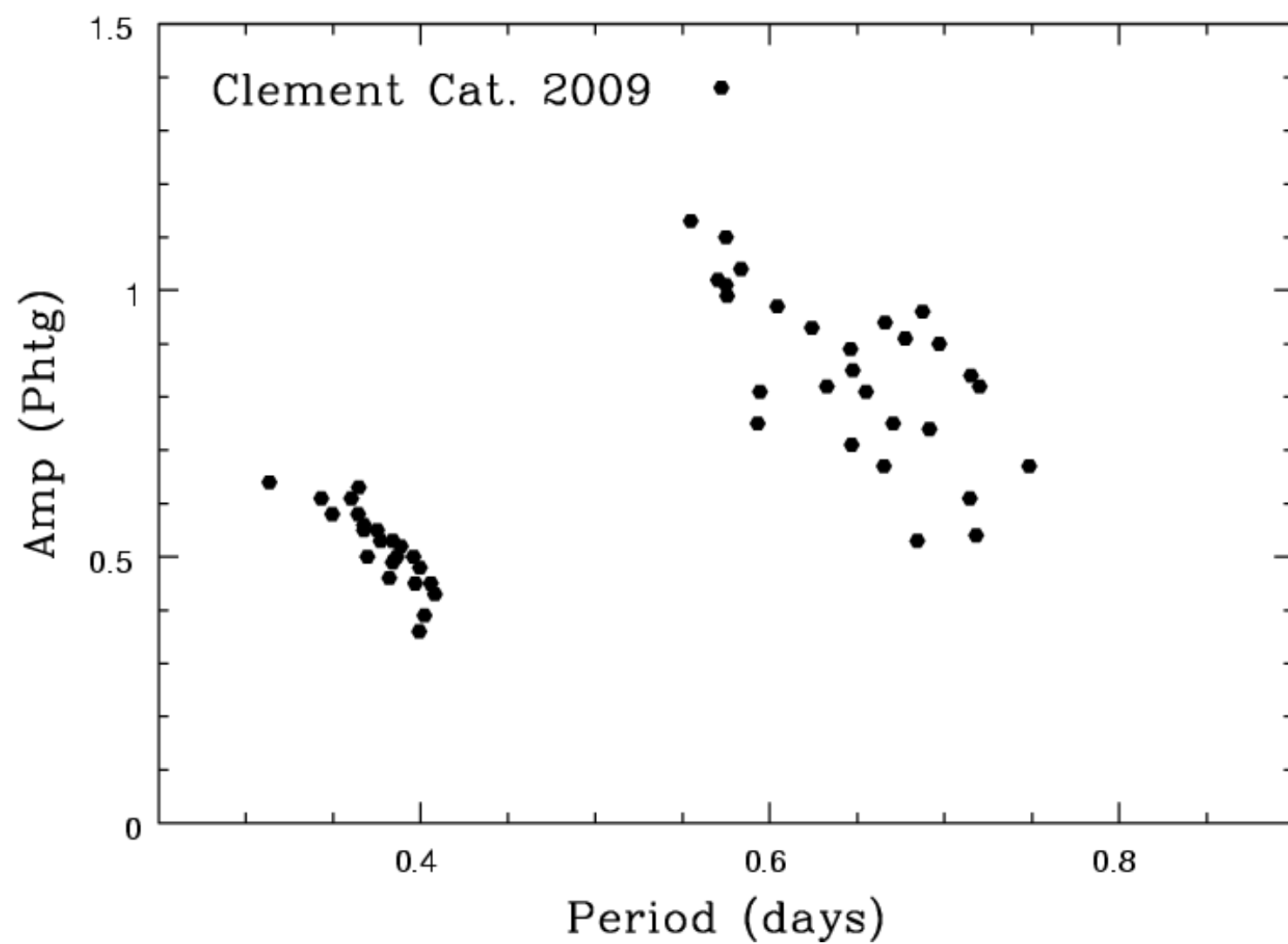
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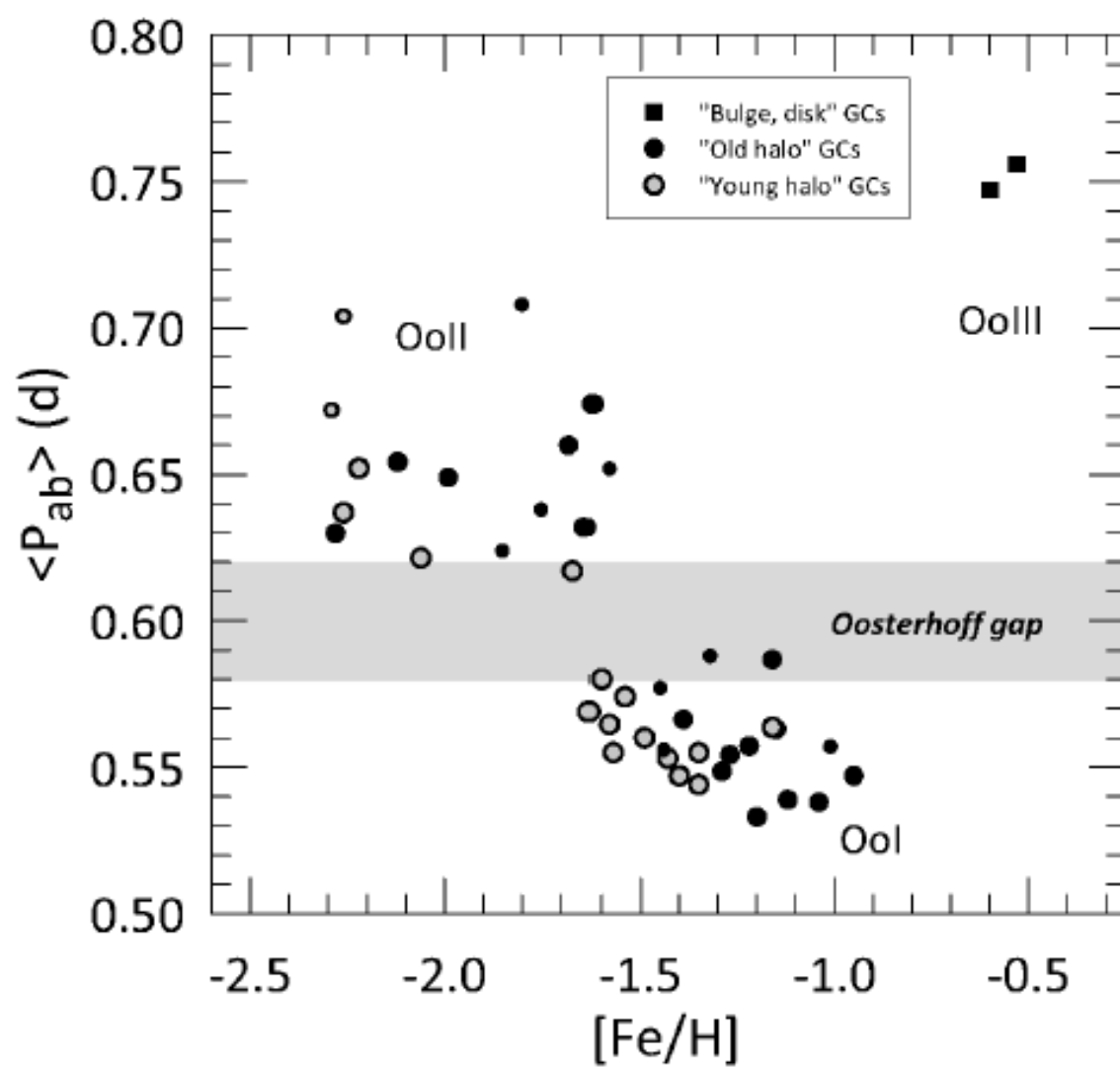


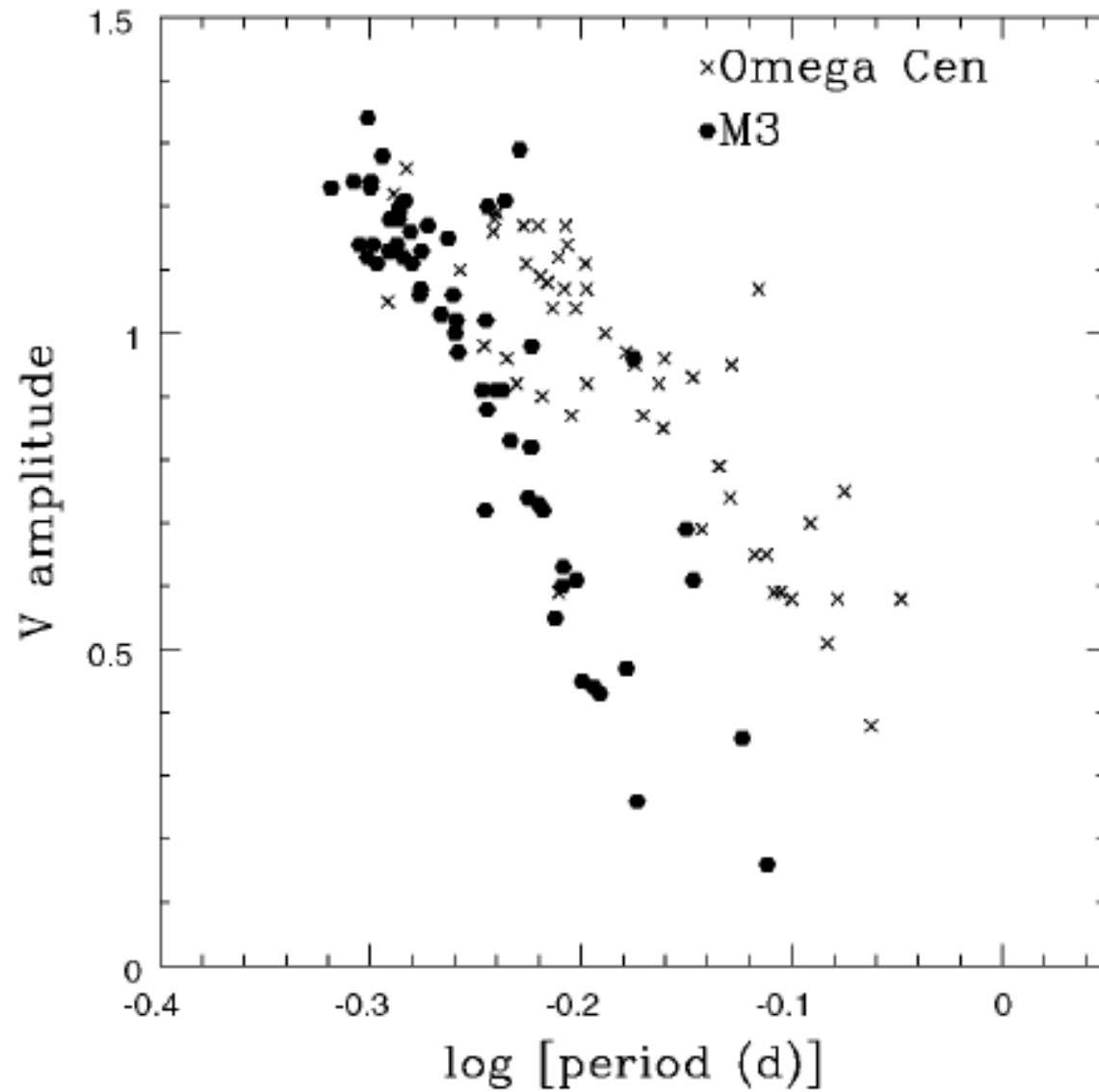
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Discovery of the Bailey types (a, b, and c) 1902



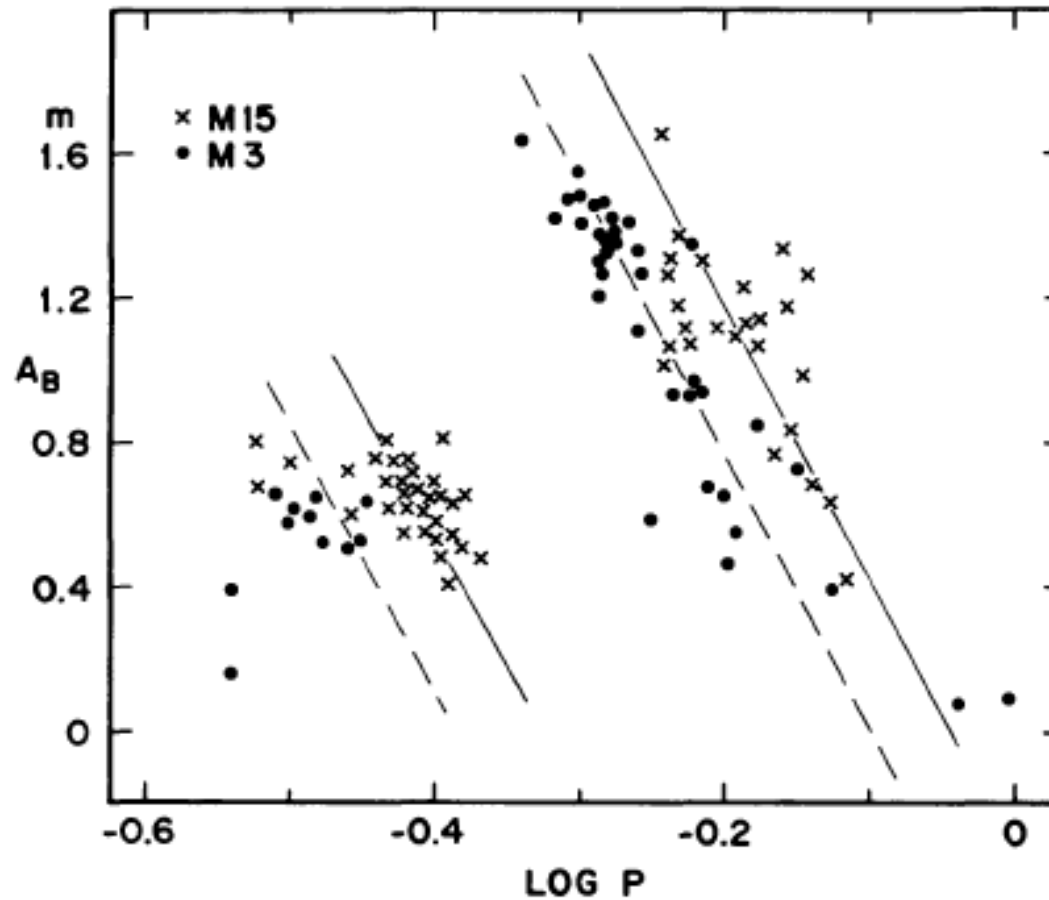






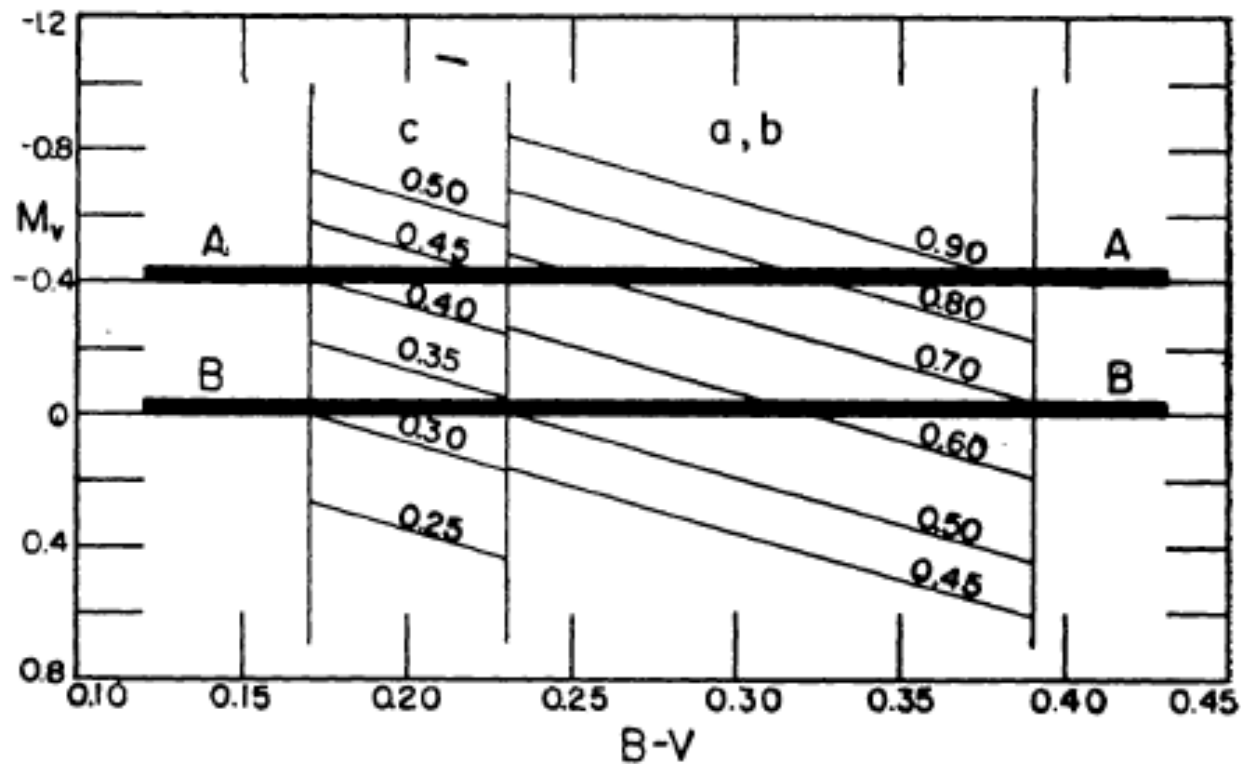
Blazhko stars excluded; data from Cacciari et al. 2005; Kaluzny et al. 2004

Shift with Oosterhoff type



From Sandage, Katem, & Sandage 1981

Oo II RR Lyrae are brighter than Oo I



Sandage 1958

Shift in P-A relation with [Fe/H] implies a shift in absolute mag with [Fe/H]

Sandage 1981, 1982

$$\Delta M_{\text{bol}}^{\text{RR}} = 0.348 \Delta [\text{Fe}/\text{H}]$$

The period-amplitude relation also began to be used for determining [Fe/H]

$$[\text{Fe}/\text{H}]_{\text{A}} = -2.60 - 8.85 \log P_{ab} - 1.33 A_V$$

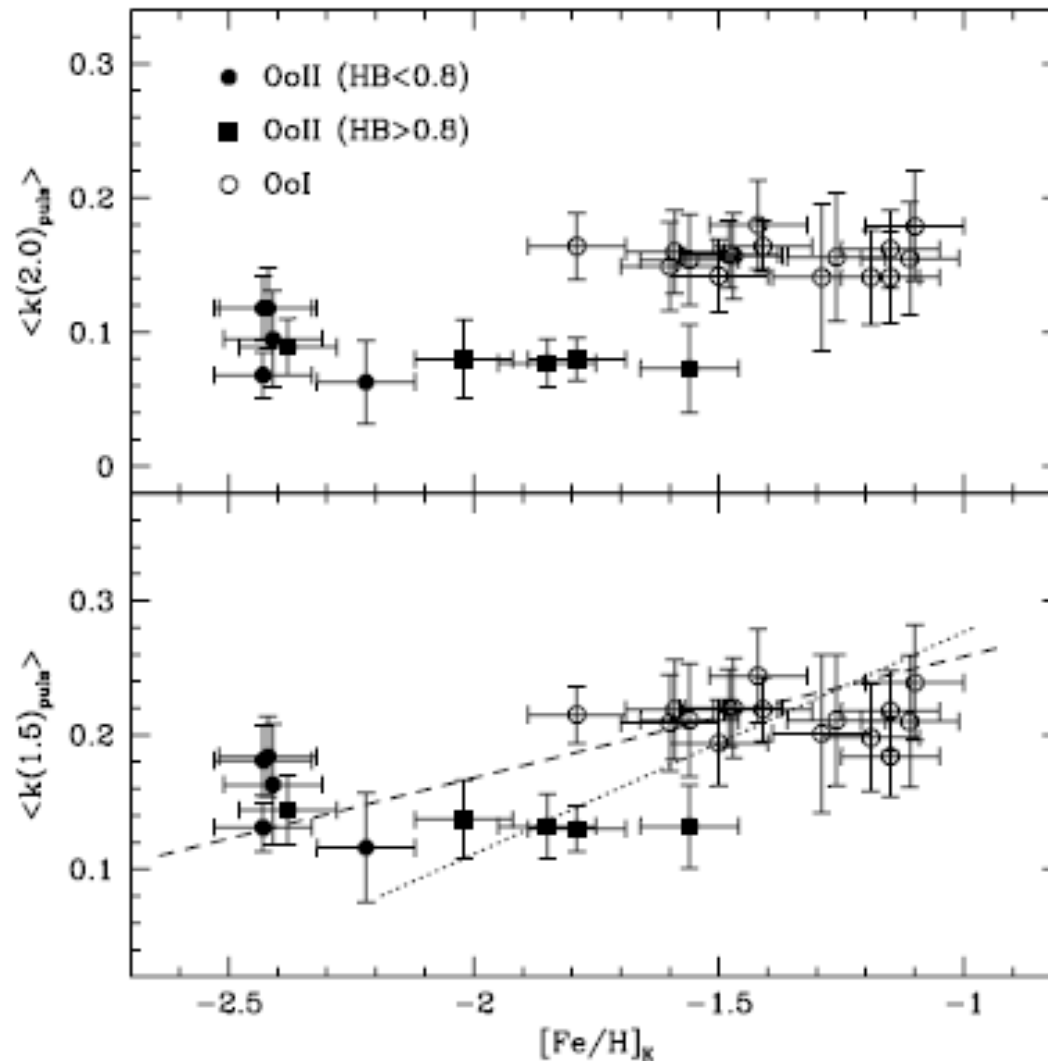
Alcock et al. 2000

But things turn out, as is often the case, to be more complicated



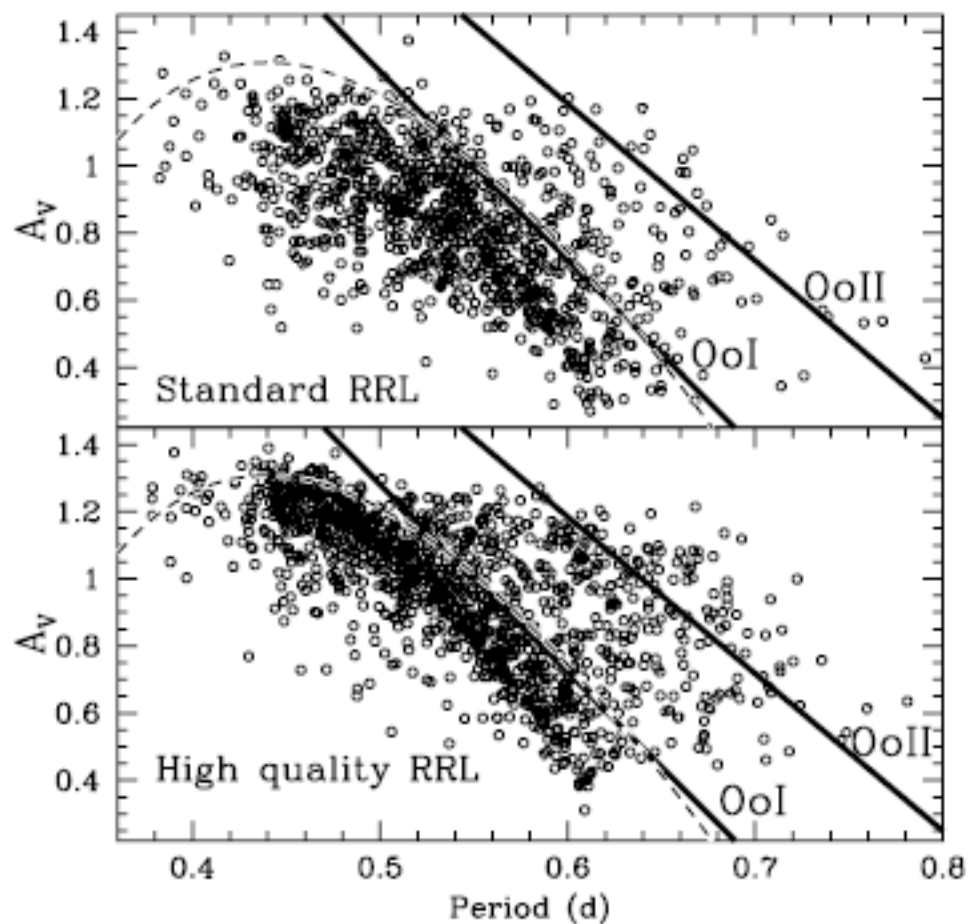
How robust is the P-A versus $[\text{Fe}/\text{H}]$ relation?

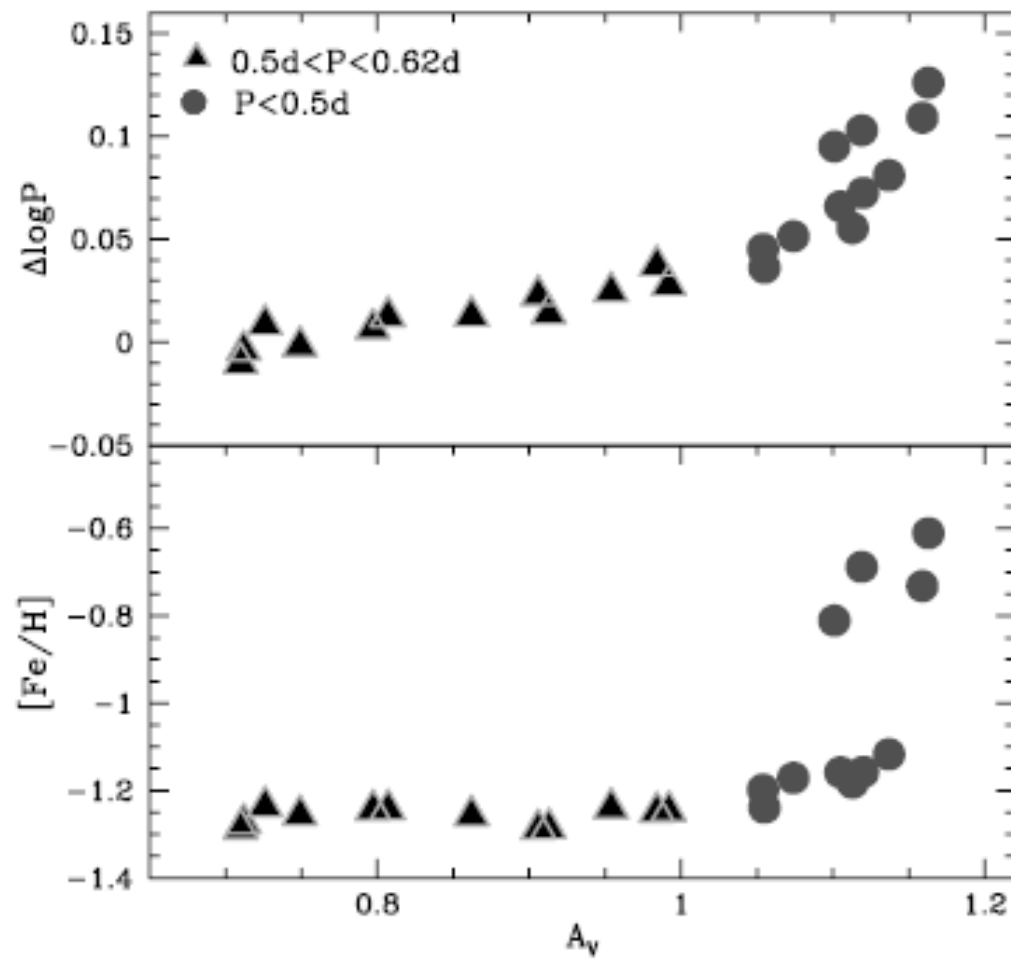
Clement & Shelton 1999; Bono et al. (2007)



Applicability of the P-A-[Fe/H] relation

Kunder & Chaboyer 2009





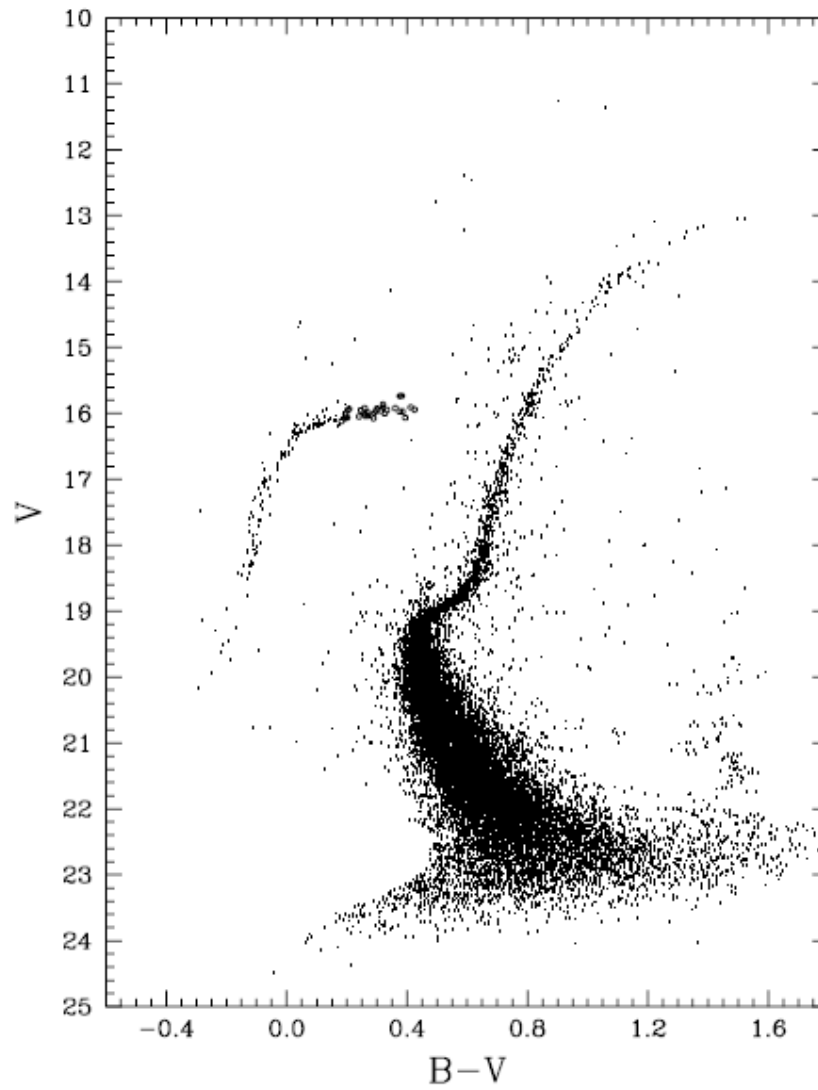
Kunder & Chaboyer 2009

M2, M3, and M62

Cluster	[Fe/H]	HB Type	<Pab>
M2	-1.62	0.92	0.725
M3	-1.57	0.18	0.555
M62	-1.29	0.55	0.548

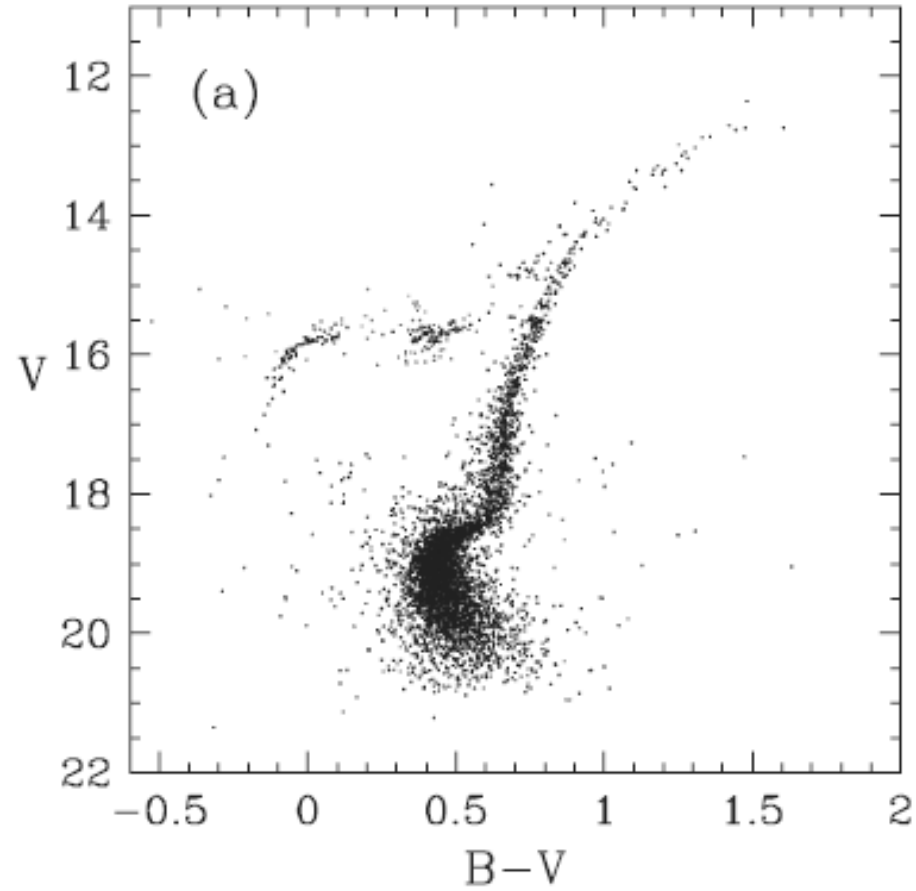
$$\text{HB Type} = (B-R)/(B+V+R)$$

M2



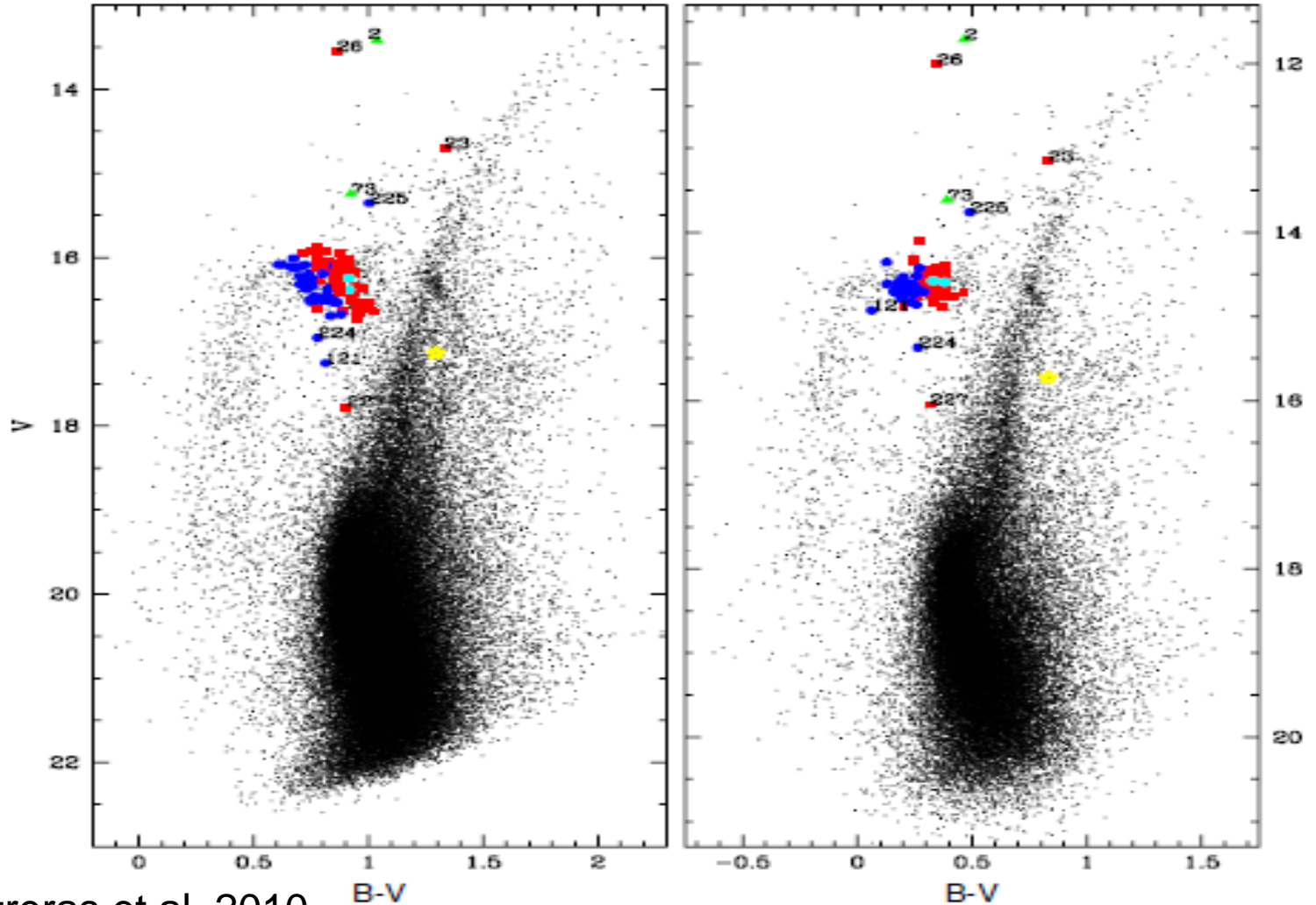
Lee & Carney 1999

M3

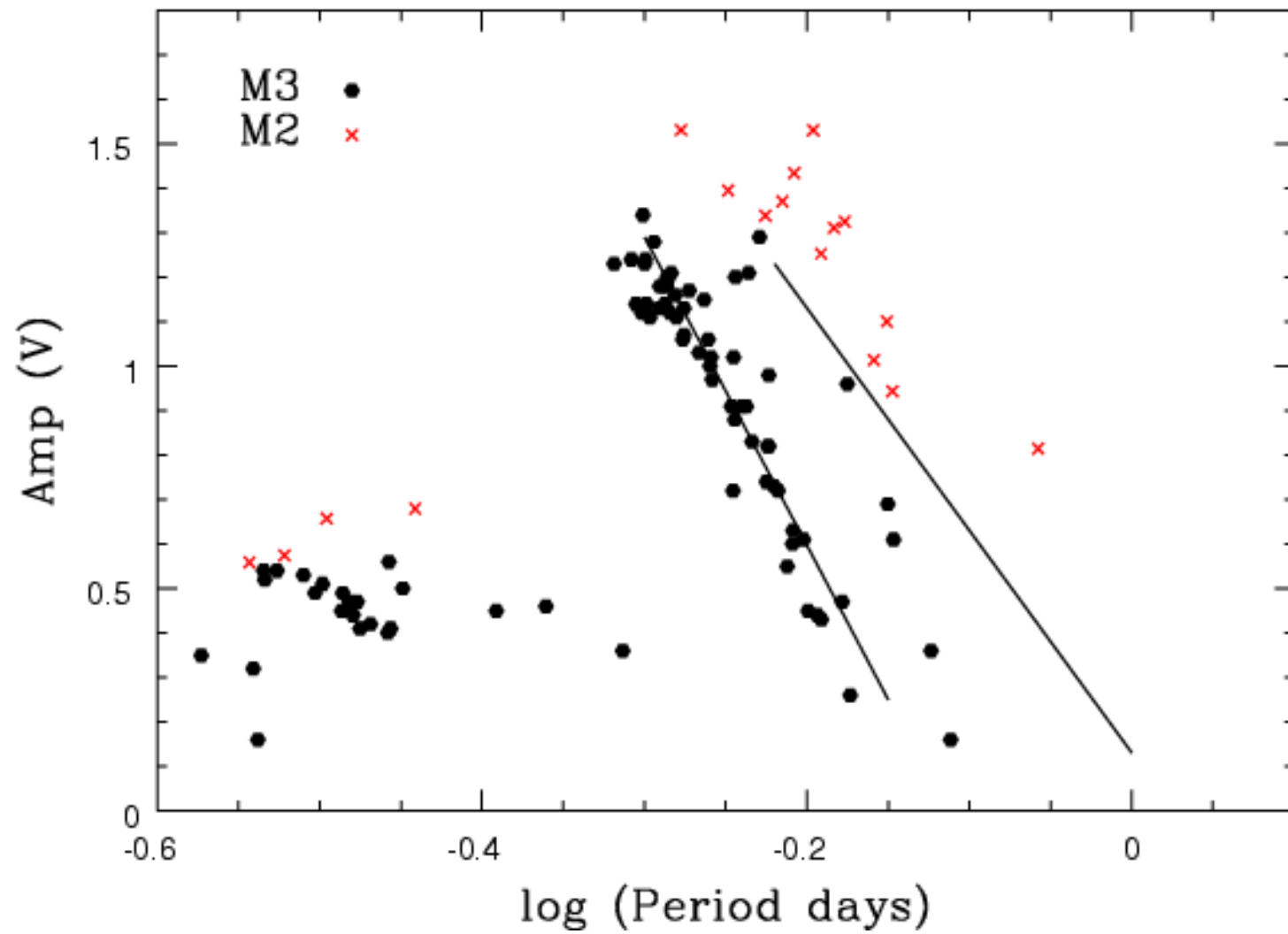


Cho et al. 2005

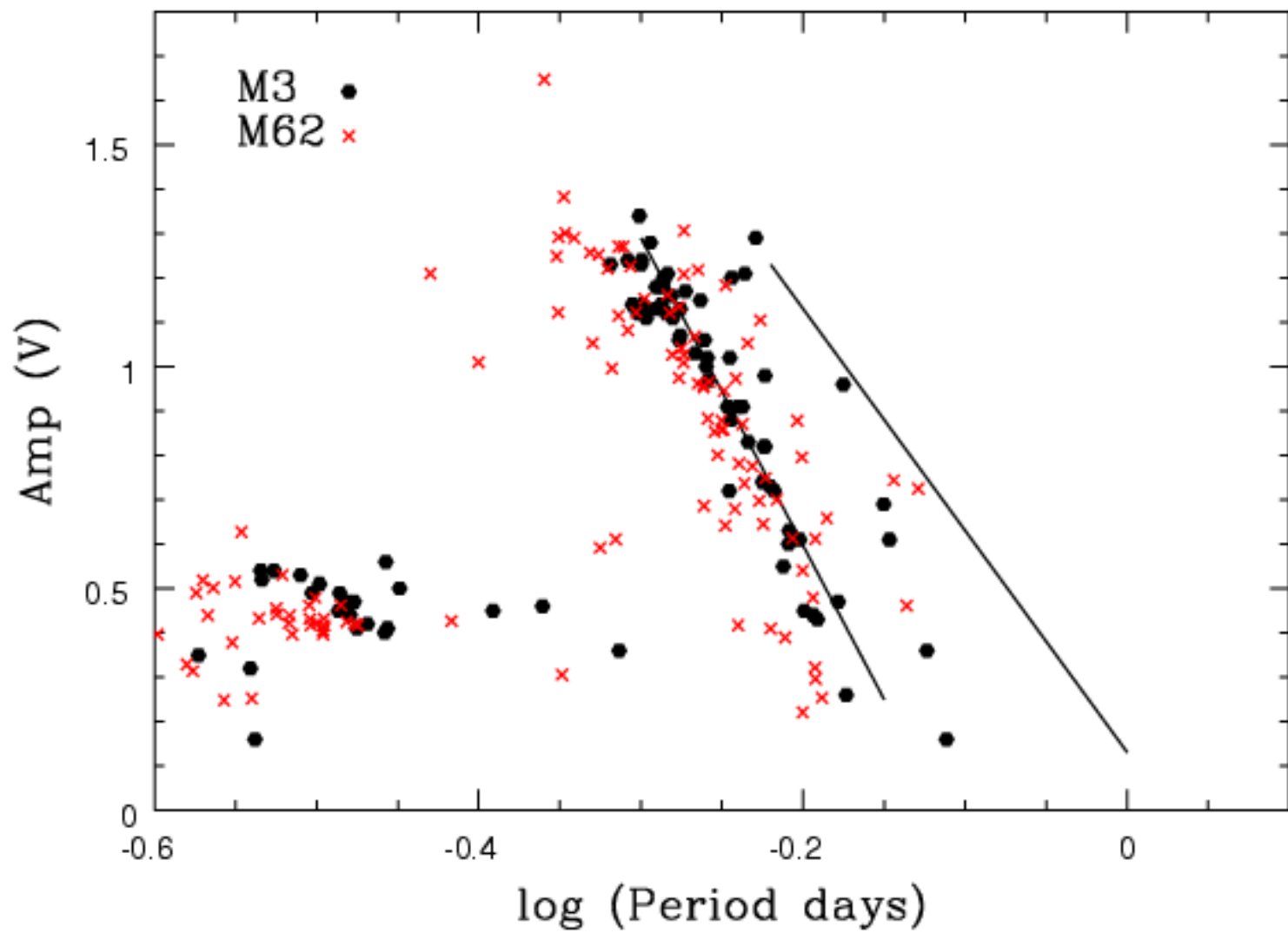
M62 (lots of RR Lyrae)



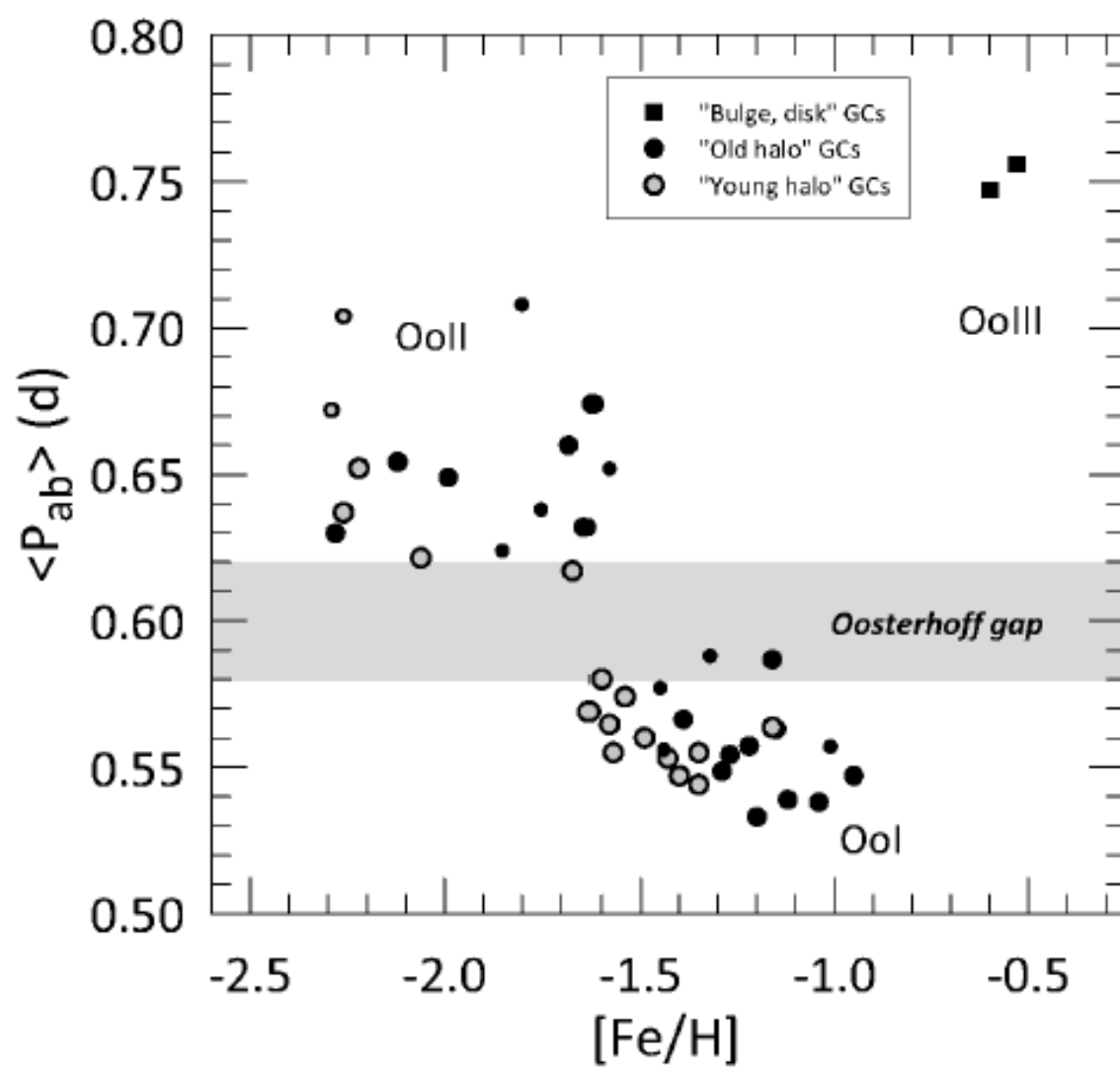
Contreras et al. 2010



Cacciari et al. 2005; Lee & Carney 1999

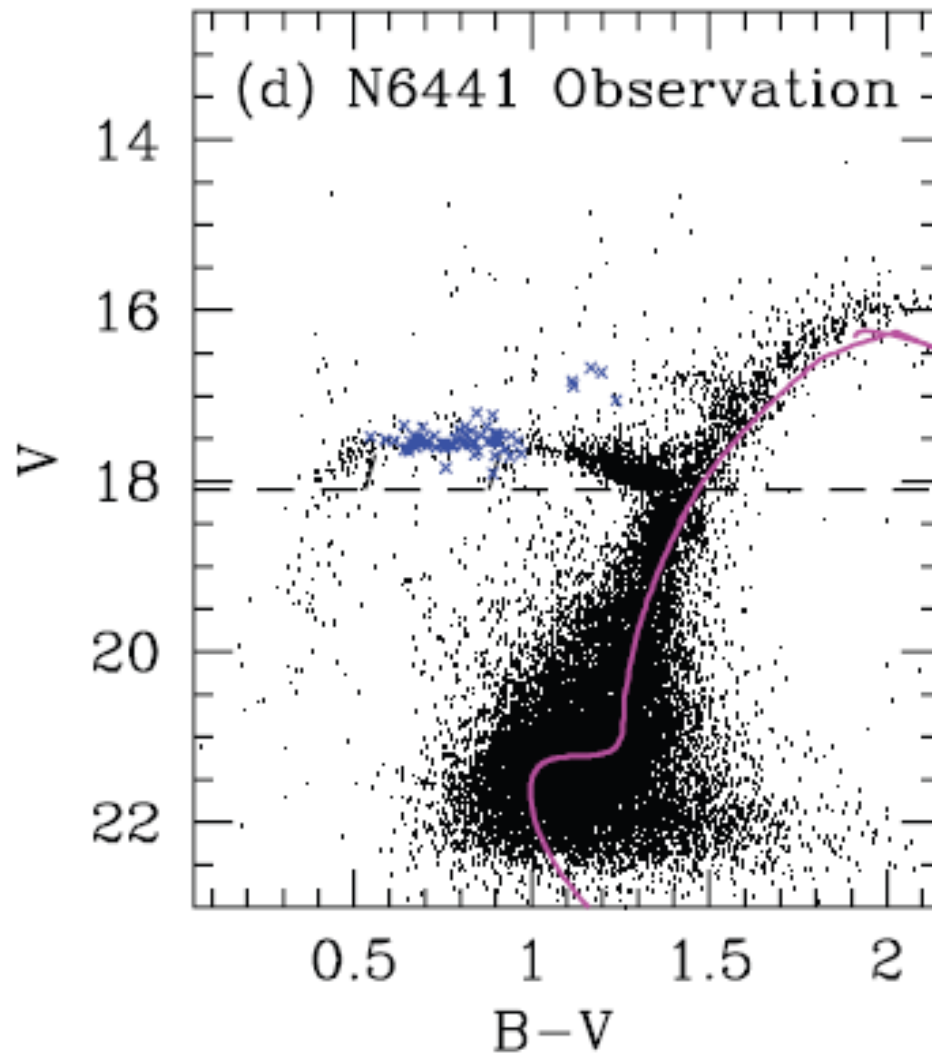


Contreras et al. 2010

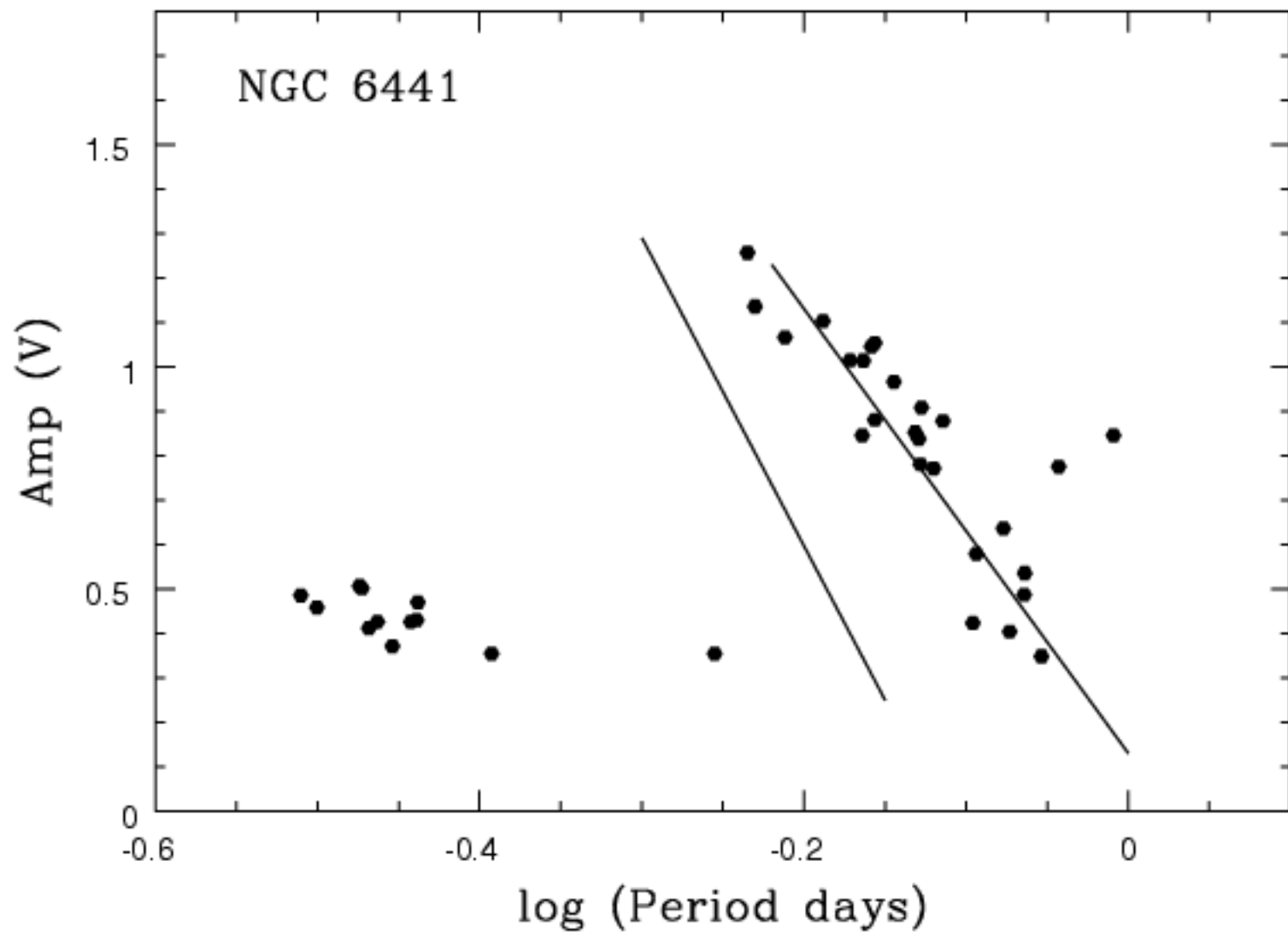


Multiple population clusters and Oo III

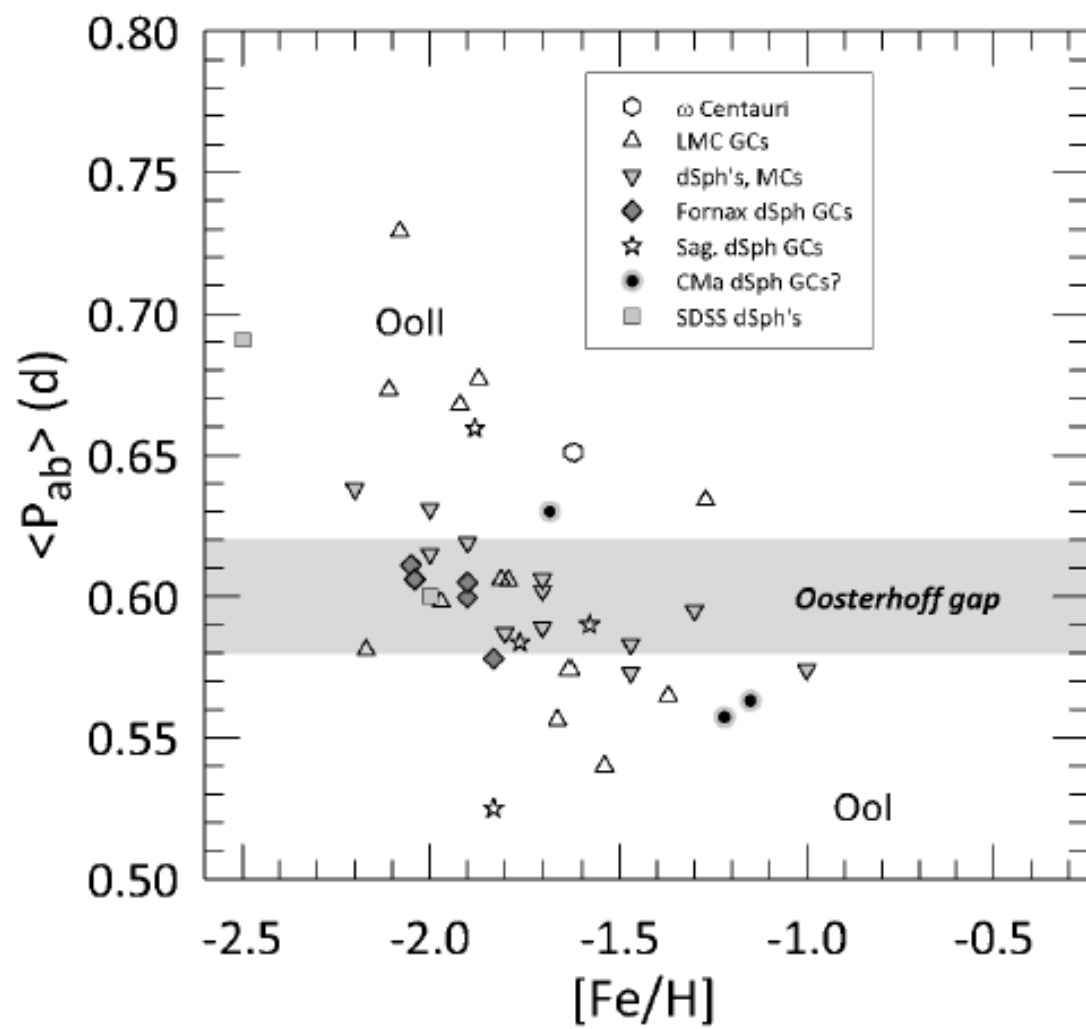
Cluster	[Fe/H]	<Pab>	HB Type
NGC 6388	-0.60	0.676 d	-0.69
NGC 6441	-0.53	0.756 d	-0.73



Rich et al. 1997; Pritzl et al. 2002,2003; Yoon et al. 2008

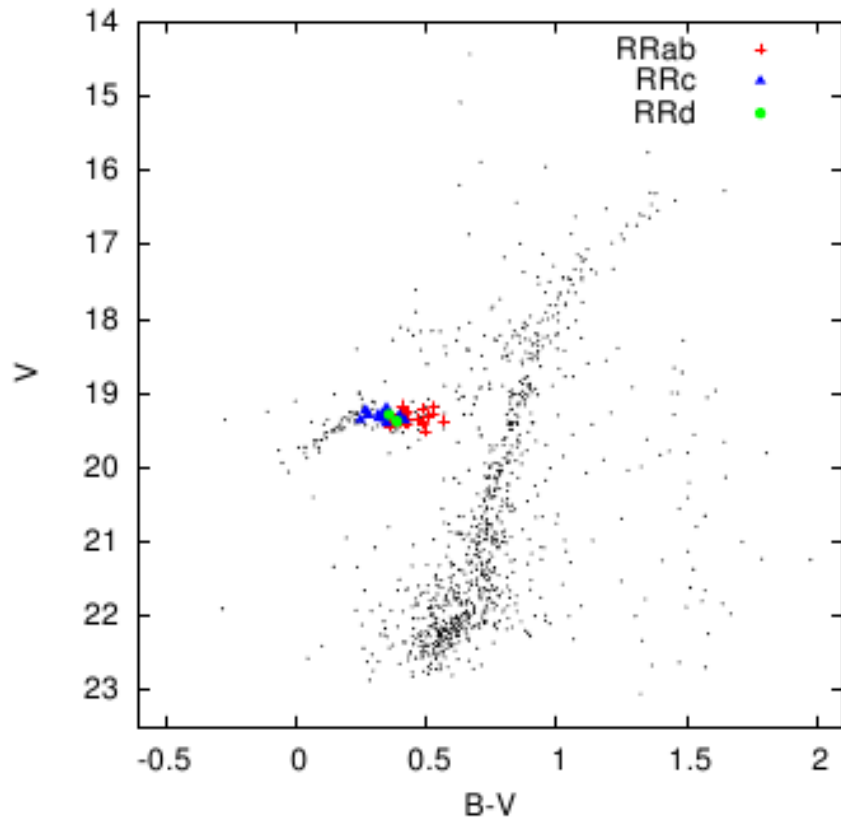


Pritzl et al. 2002, 2003



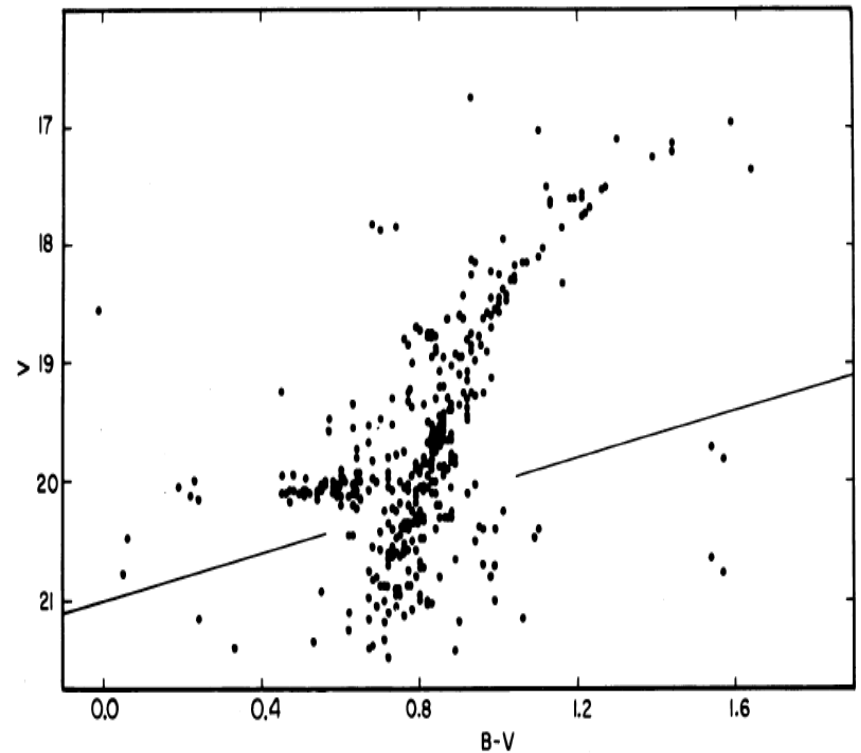
NGC 1466 and Draco

NGC 1466



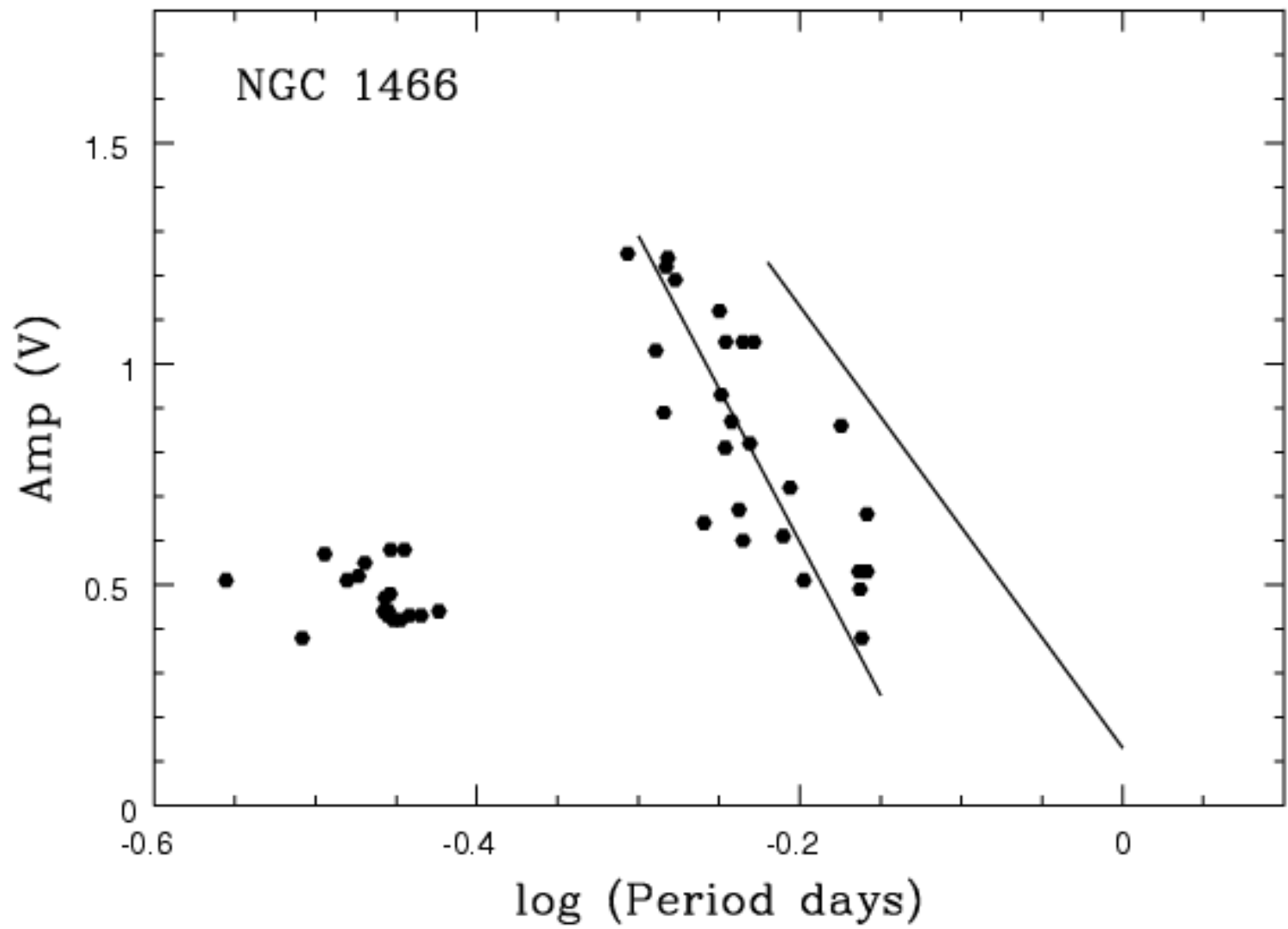
Kuehn et al. 2011

Draco

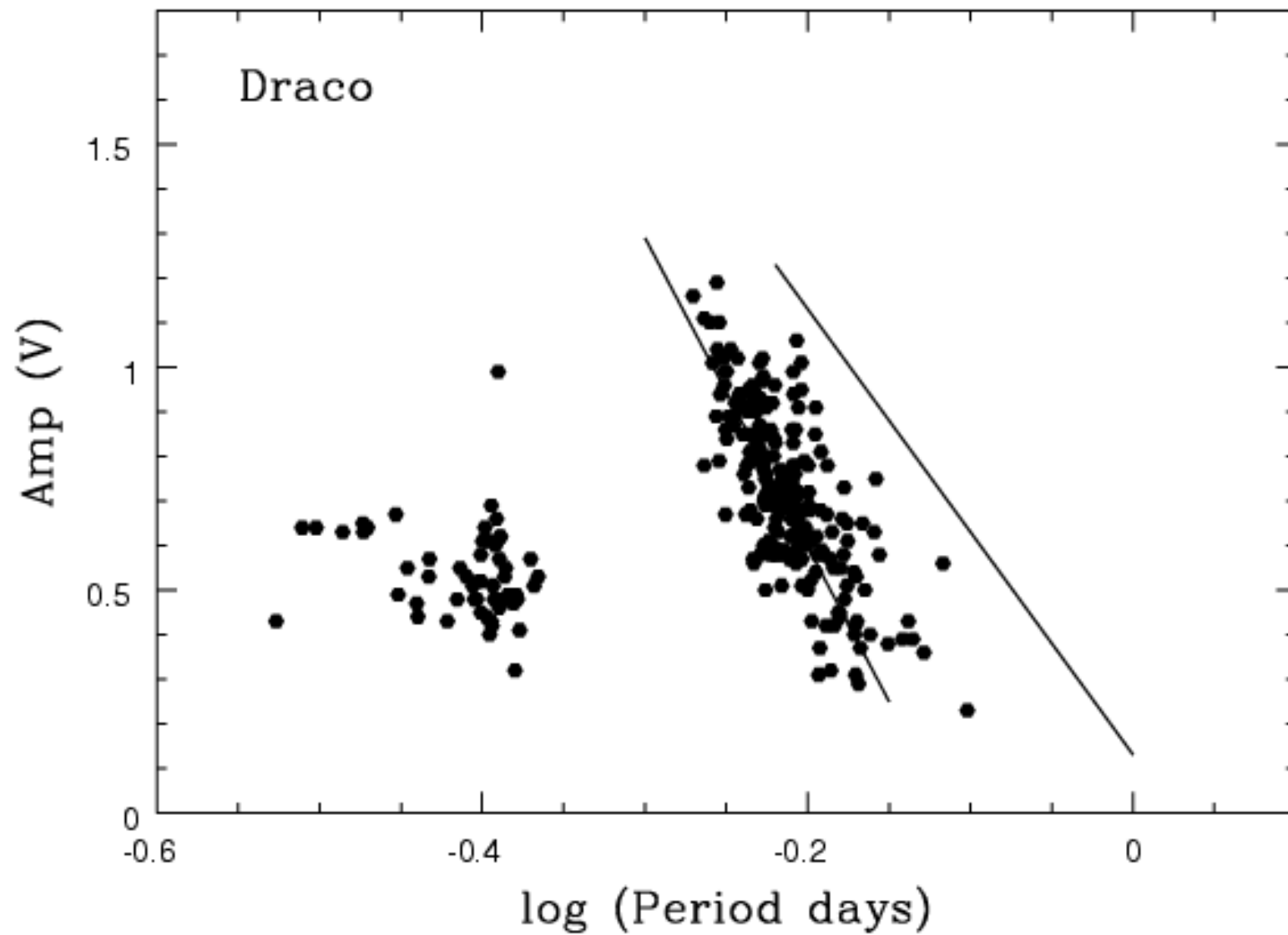


Stetson 1980

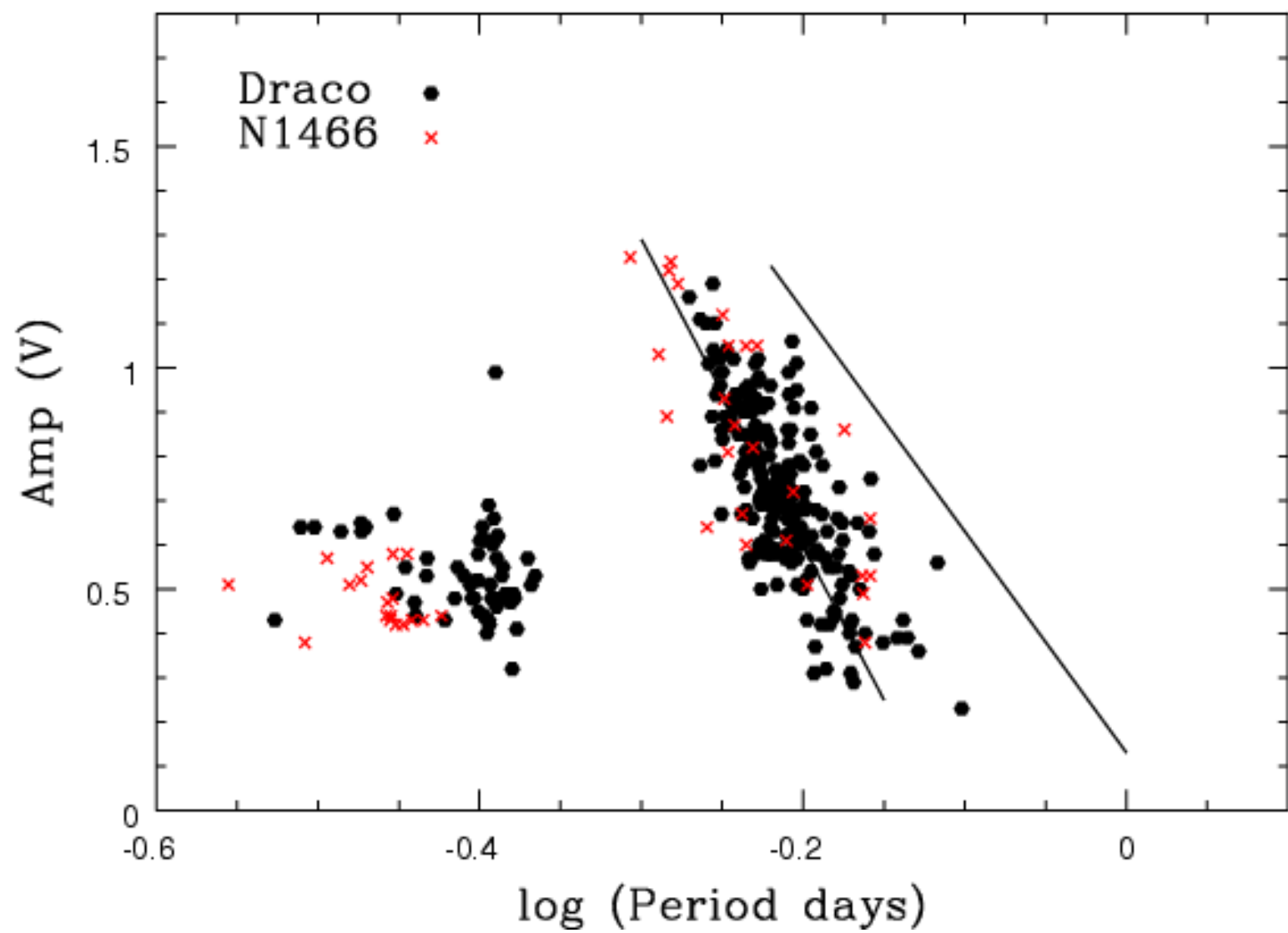
System	$\langle P_{ab} \rangle$	$[Fe/H]$
NGC 1466	0.59 d	-1.8
Draco	0.61 d	-1.5 to -3.0

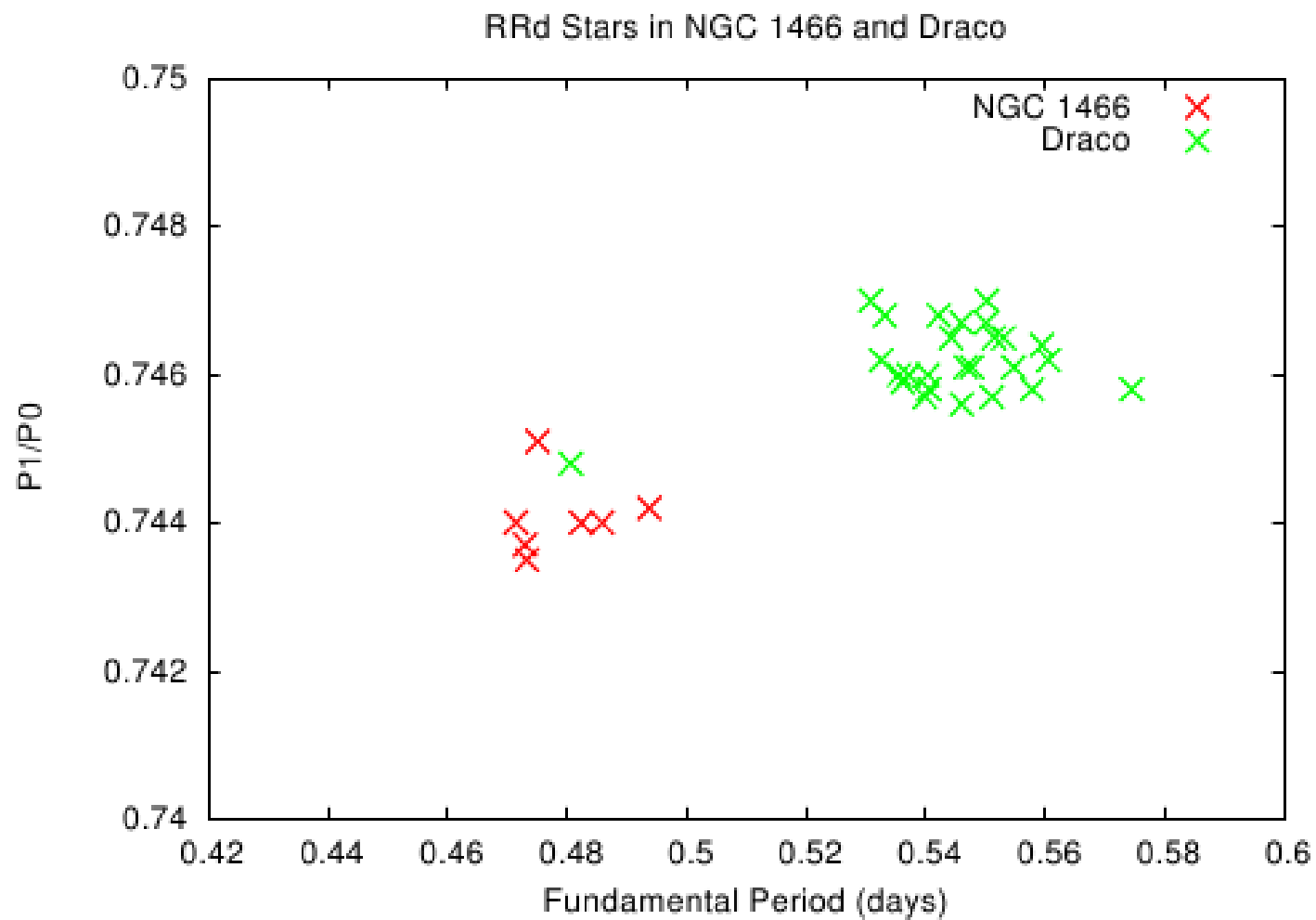


Kuehn et al. 2011



Kinemuchi et al. 2008





Kuehn et al. 2011

A few conclusions

1. Period-amplitude diagrams provide interesting information beyond what period histograms alone provide
2. A single period-amplitude-[Fe/H] relation does not always apply.
3. One can't always assume a smooth run of [Fe/H] and M_v
3. There is a clear period shift in the P-A diagrams between Oo I and Oo II clusters, and the result that Oo II RR Lyrae are brighter than Oo I stands.
4. The metal-rich RR Lyrae in NGC 6388 and NGC 6441 are clearly different from metal-rich field RR Lyrae stars
5. Don't forget about the RRc period-amplitude diagram, which can reveal some interesting differences among clusters