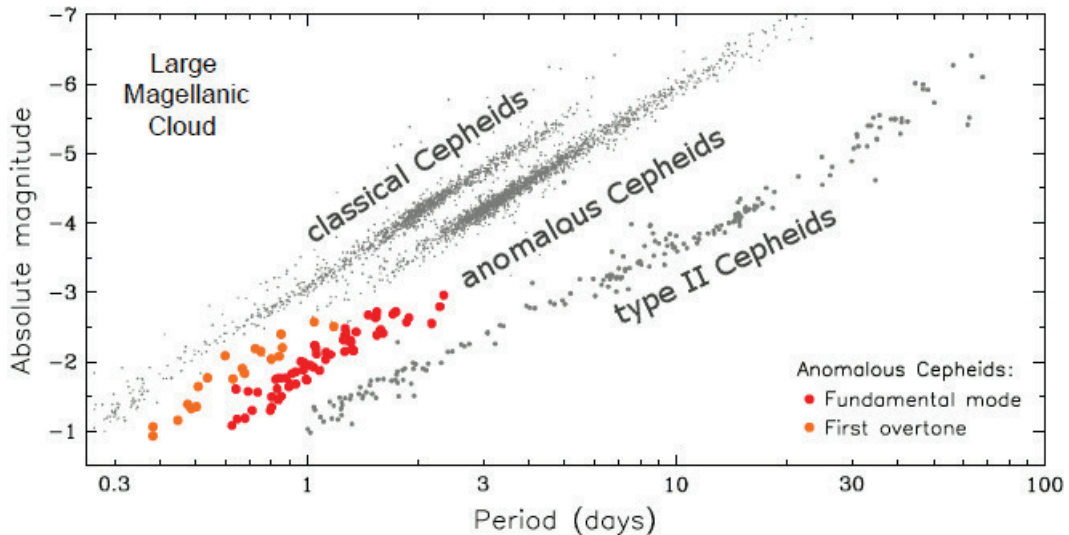


## BL Boötis stars - anomalous Cepheids

*BL Boö* is the prototype of a subclass of pulsating variable stars called the Anomalous Cepheids. These stars are similar to classical Cepheid variables, but they do not follow the same relationship between their period and luminosity.

The *Type II Cepheids* are population II variable stars which pulsate with periods typically between 1 and 50 days. These are typically metal-poor, old and low mass objects. The Type II Cepheids are divided into several subgroups by their period length. Stars with periods between 1 and 4 days are of the *BL Her* subclass, 10–20 days belong to the *W Virginis* subclass, and stars with periods greater than 20 days belong to the *RV Tauri* subclass.



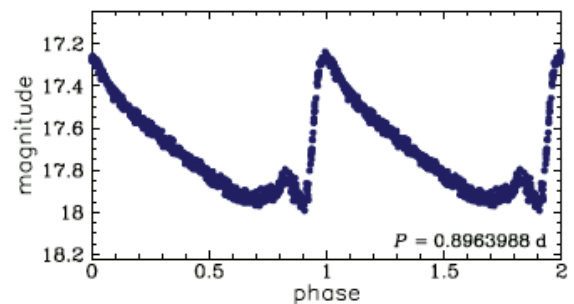
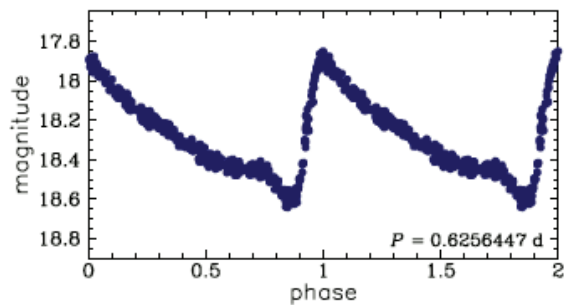
This figure illustrates the Period-Luminosity diagram for Cepheids in the Large Magellanic Cloud (Soszyński et al., 2008). Red and orange points show the position of anomalous Cepheids pulsating in the fundamental mode and first overtone, respectively. The data has been collected by the OGLE project. Image credit: <http://ogle.astrouw.edu.pl>

*BL Boötis* is a member of the NGC 5466 globular cluster (Zinn & Dahn, 1976; Zinn & King, 1982). Anomalous Cepheids are metal poor and have average masses around 1.5 solar masses. They have periods from a few hours to over 2 days, depending on whether they pulsate in the fundamental or first overtone mode. Typical light curves are asymmetric, with a sharp rise to the maximum and a slow decline. A small bump near minimum light is often seen.

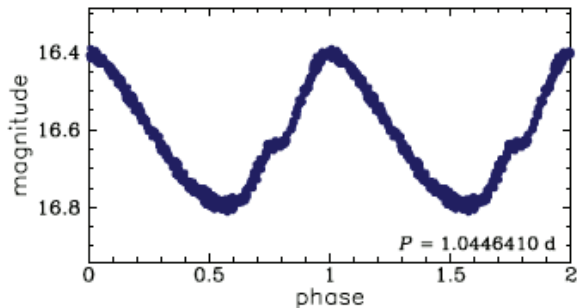
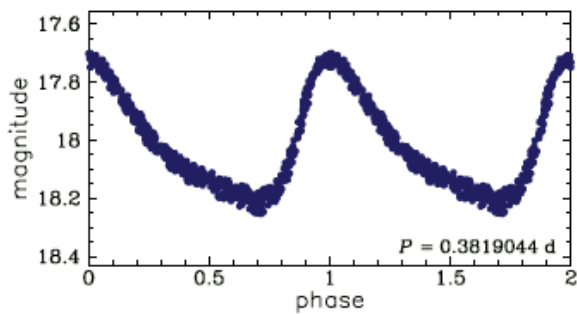
The difference between the anomalous and the Population II classes of Cepheids manifests itself in the Period Luminosity relation (see the image above). The distinctive features of these variable stars are the short pulsational period (in the period range of RRab variables) and a luminosity, which is about 2 magnitudes higher than for RR Lyrae stars of similar period. The GCVS4 refers to these stars as BLBOO variables, after variable V19 (also known as *BL Boötis*) in NGC 5466.

Light curves of anomalous Cepheids look very similar to the light curves of RR Lyrae stars and classical Cepheids, thus it is very hard to make a distinction between these types of pulsating stars. However, anomalous Cepheids are intrinsically much brighter. Most of the known ACs are found in nearby dwarf spheroidal galaxies, but a few of them are known in globular clusters.

*First-overtone* anomalous Cepheids have periods from about 0.3 days to slightly over 1 day. Generally, they have smoother light curves than the fundamental-mode pulsators, with rounded maxima and minima, although some stars exhibit a sharper maximum (Soszyński et al. 2008).



Typical light curves of anomalous Cepheids pulsating in the fundamental mode: OGLE-LMC-ACEP-068 (top), OGLE-LMC-ACEP-007 (bottom). Soszyński et al. (2008) - <http://ogle.astrouw.edu.pl>



Typical light curves of the first-overtone anomalous Cepheids pulsating: OGLE-LMC-ACEP-020 (top), OGLE-LMC-ACEP-050 (bottom). Soszyński et al. (2008) - <http://ogle.astrouw.edu.pl>

The OGLE project - <http://ogle.astrouw.edu.pl> - discovered as many as 83 anomalous Cepheids in the Large Magellanic Cloud, while the Small Magellanic Cloud has only a few candidates (Soszyński et al., 2008 & 2010). The properties of Cepheids with periods between 0.8 and 3 days in the general field, globular clusters, and nearby spheroidal galaxies have been discussed in details by Sandage, Diethelm, & Tammann (1994). The evolutionary stage of anomalous Cepheids is not known.

### XZ Ceti

Photometric variability of XZ Ceti (HD 12293) was first detected by Hoffmeister (1933). This peculiar pulsating variable has a period of 0.823156 day. It is the only anomalous Cepheid known in the Galactic field. It differs from the ordinary classical Cepheids in several respects, but the most distinctive feature is cycle-to-cycle variability of the light curve. The radial velocity phase curve is not stable either. The pulsation period is subjected to strong changes on various time scales including a very short one (Szabados et al., 2013).

The available photometric observations of XZ Ceti (e.g. Dean et al., 1977; Teays & Simon, 1977; Hipparcos, ESA, 1997 and ASAS, Pojmanski, 1997) cover about thirty years. Yet,

continued observations are necessary to study the deviations from regularity, to determine their time scale, as well as to confirm the binarity of XZ Ceti and to study its role in the observed peculiar behavior.

The list of known anomalous Cepheids has been compiled by Nemeč et al. (1994) and more recently by Pritzl et al. (2002). A modern catalog of ACs is available from the OGLE project website.

#### Several possible anomalous Cepheids located in our galaxy

Object Designation	RA (J2000)	DEC (J2000)	Var. Type (VSX)	Period, d	Mag. Range
<b>BL Boötis</b>	14 05 40.5	+28 29 12	ACEP	0.8213010	14.45 - 15.10 V
<b>XZ Ceti</b>	02 00 16.6	-16 20 46	ACEP	0.8231561	9.24 - 9.71 V
<b>UY Eridani</b>	03 13 39.1	-10 26 32	ACEP	2.21328	10.93 - 11.66 V

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