The first orbital parameters and period variation of the short-period eclipsing binary AQ Boo

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HIGHLIGHTS

- The first VRI light curves of an eclipsing contact binary AQ Boo were obtained.
- By using WD program, the photometric orbital parameters of AQ Boo were obtained.
- The orbital period of AQ Boo shows a decreasing tendency.

ARTICLE INFO

ABSTRACT

We obtained the first *VRI* CCD light curves of the short-period contact eclipsing binary AQ Boo, which was observed on March 22 and April 19 in 2014 at Xinglong station of National Astronomical Observatories, and on January 20, 21 and February 28 in 2015 at Kunming station of Yunnan Observatories of Chinese Academy of Sciences, China. Using our six newly obtained minima and the minima that other authors obtained previously, we revised the ephemeris of AQ Boo. By fitting the O-C (observed minus calculated) values of the minima, the orbital period of AQ Boo **shows** a decreasing tendency $\dot{P} = -1.47(0.17) \times 10^{-7}$ days/year. We interpret the phenomenon by mass transfer from the secondary (more massive) component to the primary (less massive) one. By using the updated Wilson & Devinney program, we also **derived** the photometric orbital parameters of AQ Boo for the first time. **We conclude** that AQ Boo **is** a near contact binary with a low contact factor of 14.43%, and will become an over-contact system as the mass transfer continues.

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1. Introduction

The **orbital** period of W UMa stars is in the **range** of about 5–20 h (Selam, 2004). It is important to study the orbital parameters, period variation, and stellar evolution (Lucy, 1967; Qian, 2002; Zhu et al., 2010; Qian et al., 2013a; Yang and Qian, 2015, etc). **The orbital** parameters of **an** eclipsing binary **can** be obtained by analyzing **the** photometric light curves (LCs) and spectra. In 1964, Hoffmeister (1964) discovered that AQ Boo **is** a variable star. Later, it was classified as one of the W UMa type eclipsing binaries by Blättler (2000), who also obtained the preliminary ephemeris of $Min.I = HJD2451602.3922(6) + 0^d.33314114(8)$ (Blättler, 2000). New minima times of AQ Boo were **published** (Diethelm, 2005; 2009; etc) and **are** available at O-C gate (Paschke and Brát, 2006)

in recent years. However, **an** orbital solution had not been obtained and **the** period variation of AQ Boo **has** also not been investigated until now.

In this paper, the primary aim is to study the first Multi-**band** CCD light curves of AQ Boo in order to obtain its orbital period variation and photometric orbital parameters. Multi-color CCD observations and data are described in Section 2. **The period** variation **is** analyzed in Section 3 and orbital parameters are **derived** in Section 4. Finally, **the** results are briefly discussed in Section 5.

2. Photometric observations

On March 22 and April 19 in 2014, we observed AQ Boo with the 60 cm telescope at Xinglong Station of the National Astronomical Observatories of China (NAOC). The CCD camera on this telescope has a resolution of 1024 × 1024 pixels and its corresponding field of view is 17' × 17' (Yang, 2013). The other three **days of** data

Table 1
The relevant parameters of AQ Boo, check and comparison stars, such as coordinates and magnitudes.

Targets	Name	Coordinates	Mag_J	Mag_H	Mag_K	Reference
Variable	AQ Boo	13:47:26.90;+17:18:24.0	11.270	10.943	10.880	Cutri et al. (2003); Samus et al. (2003)
Comparison	GSC 01460-00003	13:47:03.82;+17:22:05.4	11.353	10.962	10.905	Cutri et al. (2003); Morrison et al. (2001)
Check	GSC 01460-00206	13:47:28.62;+17:19:09.7	11.714	11.224	11.127	Cutri et al. (2003); Morrison et al. (2001)
Check	2mass J13470701+1719518	13:47:07.01;+17:19:51.8	12.919	12.345	12.224	Cutri et al. (2003); Morrison et al. (2001)
Check	2mass J13470309+1714495	13:47:03.09;+17:14:49.5	11.661	11.130	10.968	Cutri et al. (2003); Morrison et al. (2001)
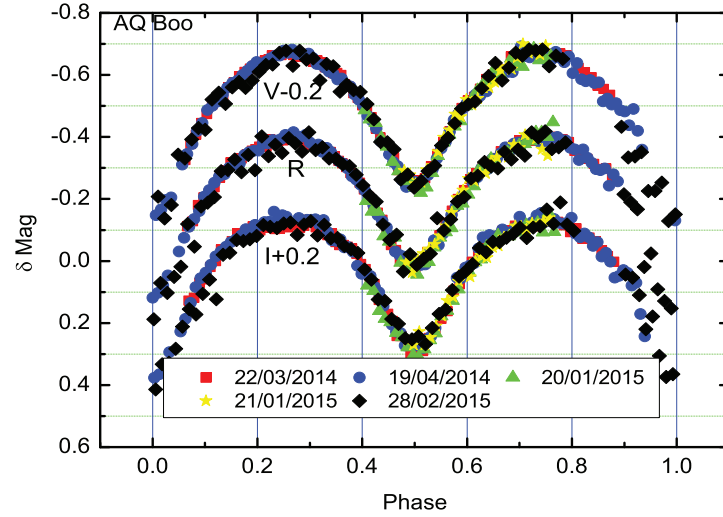
Fig. 1. The *VRI* light curves observed using 60 cm and 1 M telescope with squares (□) representing Mar. 22, 2014 data, circles (○) representing Apr. 19, 2014 data, triangles (△) representing Jan. 20, 2015 data, stars (⋆) representing Jan. 21, 2015 data, and diamonds (◇) representing Feb. 28, 2015 data.

Table 2
Our photometric data of AQ Boo in V R and I bands observed using 60 cm and 1 **m** telescope.

V band		R band		I band		Telescope
HJD	Δ mag	HJD	Δ mag	HJD	Δ mag	
2456739.0797	−0.076	2456739.0811	−0.062	2456739.0819	−0.023	60cm
2456739.0832	−0.127	2456739.0846	−0.078	2456739.0854	−0.032	60cm
2456739.0866	−0.158	2456739.0880	−0.131	2456739.0888	−0.080	60cm
2456739.0900	−0.195	2456739.0914	−0.155	2456739.0923	−0.091	60cm
2456739.0935	−0.224	2456739.0949	−0.168	2456739.0957	−0.131	60cm
2456739.0969	−0.255	2456739.0983	−0.188	2456739.0991	−0.150	60cm
...	...	...	...	...	...	
2456767.0442	0.102	2456767.0422	0.168	2456767.0432	0.226	60cm
2456767.0410	0.119	2456767.0454	0.153	2456767.0464	0.215	60cm
2456767.0474	0.083	2456767.0486	0.129	2456767.0496	0.187	60cm
2456767.0506	0.053	2456767.0518	0.096	2456767.0528	0.144	60cm
2456767.0538	0.045	2456767.0588	0.019	2456767.0598	0.077	60cm
2456767.0608	−0.061	2456767.0620	−0.025	2456767.0630	0.036	60cm
...	...	...	...	...	...	
2457043.3468	−0.236	2457043.3477	−0.144	2457043.3483	−0.071	1m
2457043.3499	−0.207	2457043.3513	−0.109	2457043.3522	−0.054	1m
2457043.3537	−0.195	2457043.3551	−0.109	2457043.3560	0.011	1m
2457043.3573	−0.147	2457043.3587	−0.030	2457043.3596	0.036	1m
...	...	...	...	...	...	
2457044.3733	−0.041	2457044.3747	0.054	2457044.3756	0.106	1m
2457044.3769	−0.027	2457044.3783	0.087	2457044.3792	0.121	1m
2457044.3805	0.001	2457044.3819	0.046	2457044.3828	0.078	1m
2457044.3841	−0.004	2457044.3855	0.027	2457044.3864	0.121	1m
...	...	...	...	...	...	
2457082.1552	−0.183	2457082.1567	−0.165	2457082.1577	−0.106	1m
2457082.1594	−0.084	2457082.1610	−0.140	2457082.1621	−0.096	1m
2457082.1637	−0.087	2457082.1610	−0.140	2457082.1664	−0.040	1m
2457082.1680	−0.101	2457082.1653	−0.117	2457082.1707	0.070	1m
2457082.1723	0.024	2457082.1696	0.069	2457082.1750	0.029	1m
2457082.1765	0.024	2457082.1739	0.026	2457082.1793	0.156	1m