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Three new variable stars in the field of the RR Lyrae star AK Gem

F.-J. HAMBSCH [1,2]
1) Bundesdeutsche Arbeitsgemeinschaft für Veränderliche Sterne e.V. (BAV), Germany
2) Vereniging Voor Sterrenkunde, Belgium, hambsch @ telenet . be

Abstract: Three new variable stars (HMB06 = USNO-B1.0 1035-0121819, HMB07 = USNO-B1.0 1036-0121306 and HMB08 = USNO-B1.0 1035-0121640) have been identified in the field of the RR Lyrae type variable AK Gem. Full light curves for all the three stars are presented. The form of the light curve indicates that all the three stars are EW type variable stars.
For HMB06 a period P = 0.32667 +/- 0.00012 [d] with the epoch E_0 = HJD 2454155.699 and an amplitude of the light variation of Δm = 0.6 +/- 0.1 mag. has been found. For HMB07 a period P = 0.53284 +/- 0.00017 [d] with the epoch E_0 = HJD 2454155.683 and an amplitude of the light variation of Δm = 0.45 +/- 0.05 mag. has been found. And finally for HMB08 a period P = 0.43257 +/- 0.00024 [d] with the epoch E_0 = HJD 2454155.742 and an amplitude of the light variation of Δm = 0.25 +/- 0.1mag. has been found.

Following the light curve variation of the RR Lyrae star AK Gem in the constellation Gemini has resulted in 14 days of CCD observations of the field using a 50 cm f/8.2 Ritchey Chrétien telescope and the STL11000XM CCD camera with a clear filter. The field covered by this CCD is 30 x 20 arcmin^2. During inspection of the stars in the field with the program package C-Munipack **(Motl, 2006)** three other stars showing variability were detected. The first star HMB06 = USNO-B1.0 1035-0121819 (average R - Mag. 16.36 from the USNO-B1.0 catalog) in the list is at Right ascension: 6h 54m 46.03s and Declination: +13 35' 31.1". The star has been observed during 11 nights between Feb. 23 and April 4, 2007, a time span of about 40 days. This resulted in 1943 CCD observations. No filter was used during the investigation. The image exposure was 40 sec. As comparison star the star USNO-B1.0 1037-0121649 was used. Its position and magnitude (based on data from GUIDE8 **(Gray, 2006)** are:

6h55m04.99s +13 42' 26.5" 14.25 (average R-magnitude)

The comparison and check stars have been the same as for AK Gem due to the large field of view of the CCD used. A finder chart is given in Fig. 1. The resulting light curve of the star is given in Fig. 2. Relative magnitude differences are given. A very symmetric light curve is visible. The secondary minimum is not as deep as the primary one by about 0.05 mag. The period was found with the period analysis software Peranso 2.11 **(Vanmunster, 2006)**. The derived elements for the minima of this star are the following:

P = 0.32667 +/- 0.00012 [d] with the epoch E_0 = HJD 2454155.699 and an amplitude of the light variation of Δm = 0.6 +/- 0.1 mag.

The following minima for this star could be deduced:

Delta Mag.	Type of Minimum	JD	Error
3.18	secondary	2454161.7404	0.0024
3.17	secondary	2454163.6995	0.0028
3.25	primary	2454168.7630	0.0020
3.23	primary	2454169.7443	0.0016

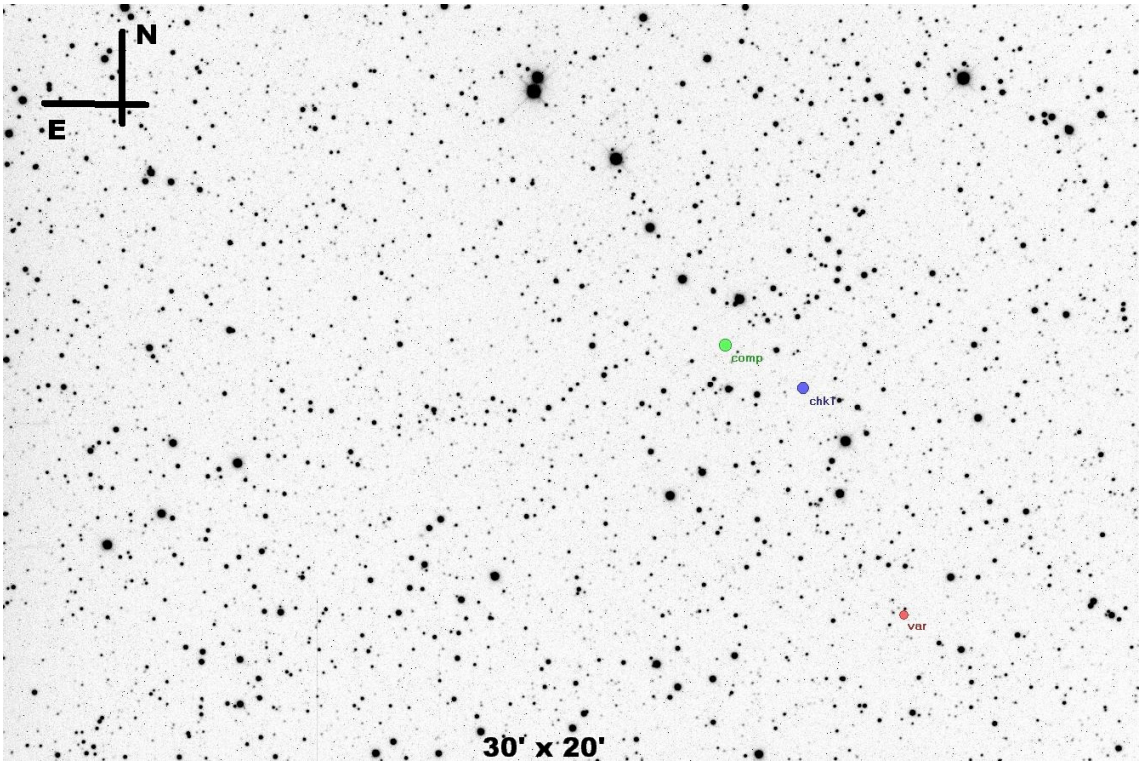

Fig. 1. Finding chart of the star HMB06 = USNO-B1.0 1035-0121819. The star is indicated by the red circle. Comparison star (green circle) and check star (blue circle) are also given.

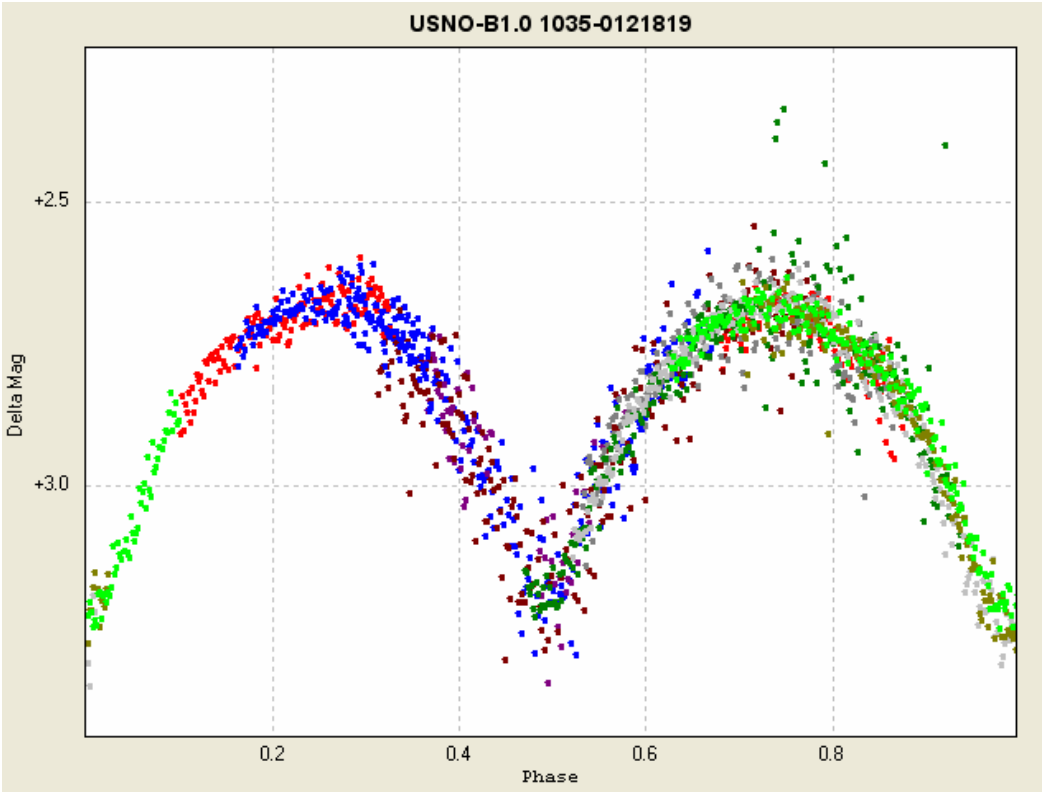

Fig. 2. Phase diagram of the star HMB06 = USNO-B1.0 1035-0121819. The different colours are the different observing runs covering a period of 11 nights.

A second star HMB07 = USNO-B1.0 1036-0121306 (average R-Mag. 14.54) at position Right ascension: 6h 54m 47.70s and Declination: +13 36' 48.9" is also variable. The star has been observed during 14 nights between Feb. 23 and April 4, 2007. This resulted in 2772 CCD observations. No filter was used during the investigation. The image exposure was 40 sec. As comparison star the star USNO-B1.0 1037-0121649 as above was used. A finder chart is given in Fig. 3. The resulting light curve of the star is given in Fig. 4. Relative magnitude differences are given. A very symmetric light curve is visible. The secondary minimum is obviously not as deep as the primary one. Also the first hump of the phase diagram seems to be more broadened than the second hump. This might be an indication of starspots on one of the components of this binary system.
The period was found with the period analysis software Peranso 2.11 **(Vanmunster, 2006)**. The derived elements for the minima of this star are the following:

P = 0.53284 +/- 0.00017 [d] with the epoch E_0 = HJD 2454155.683 and an amplitude of the light variation of Δm = 0.45 +/- 0.05 mag.

The following minima for this star could be deduced:

Delta Mag.	Type of Minimum	JD	Error
0.79	primary	2454163.6670	0.0034
0.77	primary	2454164.7400	0.0032
0.73	secondary	2454167.6682	0.0031
0.74	secondary	2454168.7324	0.0039
0.79	primary	2454187.6436	0.0022
0.77	primary	2454195.6387	0.0031

The minima are rather broad, which is reflected in the uncertainty of the determination (see above table). This indicates total eclipses in both minima.

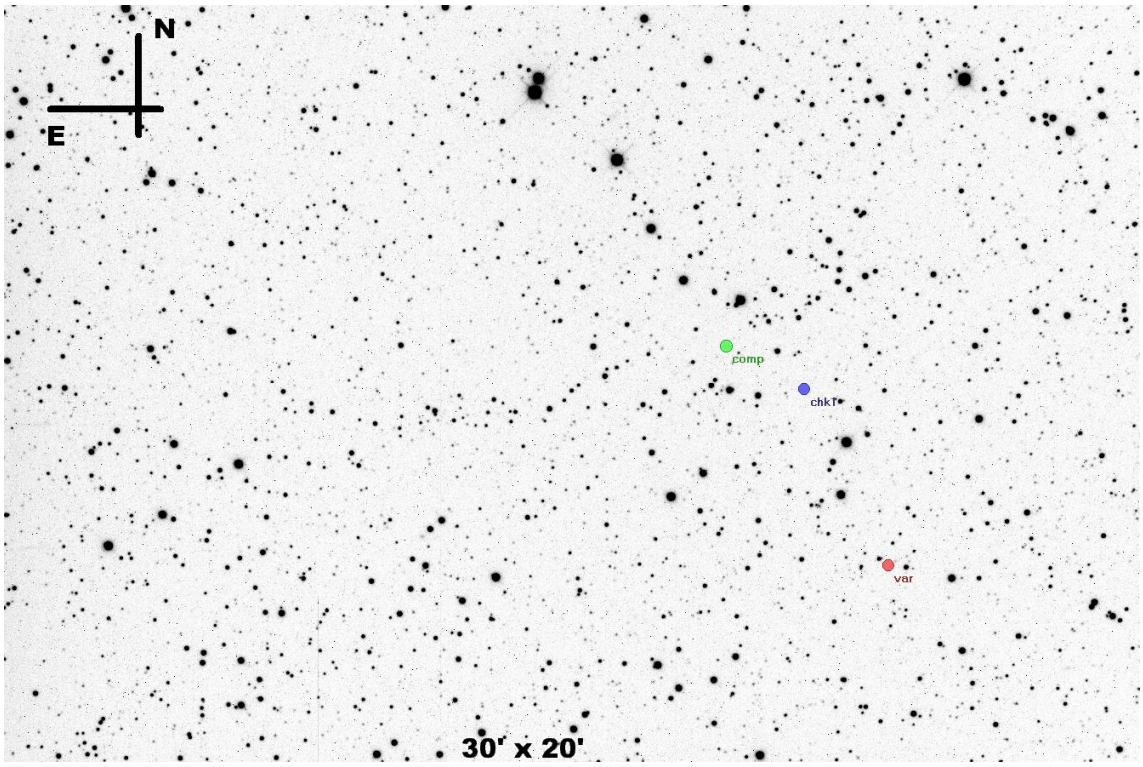

Fig. 3. Finding chart of the star HMB07 = USNO-B1.0 1036-0121306. The star is indicated by the red circle. Comparison star (green circle) and check star (blue circle) are also given.

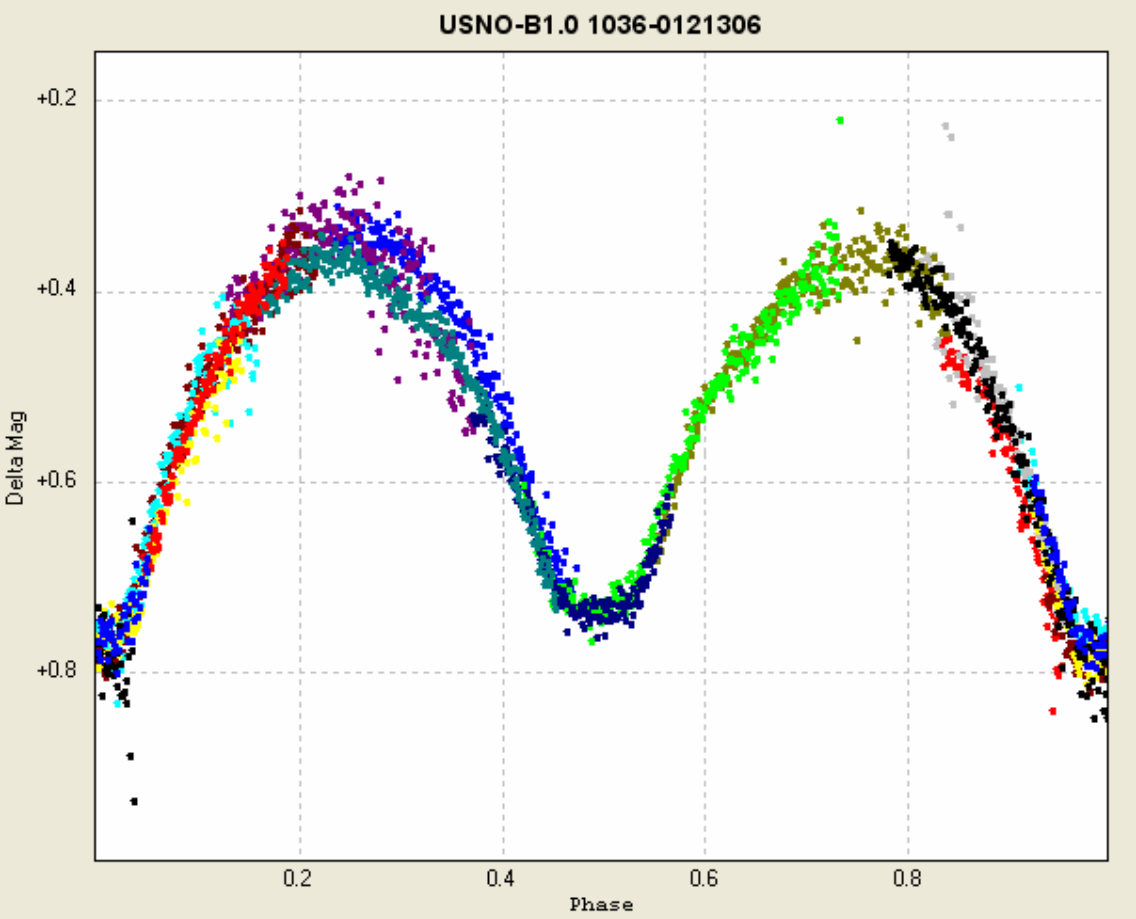

Fig. 4. Observed light curve segments of the star HMB07 = USNO-B1.0 1036-0121306. The different colors are for the different observing runs covering a period of 14 nights.

The third star HMB08 = USNO-B1.0 1035-0121640 (average R-Mag. 15.47) at position Right ascension: 6h 54m 32.59s and Declination: +13 33' 41.8" is also variable. The star has been observed during 14 nights between Feb. 23 and April 4, 2007. This resulted in 2594 CCD observations. No filter was used during the investigation. The image exposure was 40 sec. As comparison star the star USNO-B1.0 1037-0121649 as above was used. A finder chart is given in Fig. 5. The resulting light curve of the star is given in Fig. 6. Relative magnitude differences are given. A very symmetric light curve, though very noisy, is visible. The secondary minimum is slightly shallower compared to the primary one. The period was found with the period analysis software Peranso 2.11 **(Vanmunster, 2006)**. The derived elements for the minima of this star are the following:

P = 0.43257 +/- 0.00024 [d] with the epoch E_0 = HJD 2454155.742 and an amplitude of the light variation of Δm = 0.25 +/- 0.1mag.

The following minima for this star could be deduced:

Delta Mag.	Type of Minimum	JD	Error
1.95	primary	2454168.7244	0.0031
1.89	secondary	2454163.7489	0.0050
1.92	primary	2454188.6171	0.0026

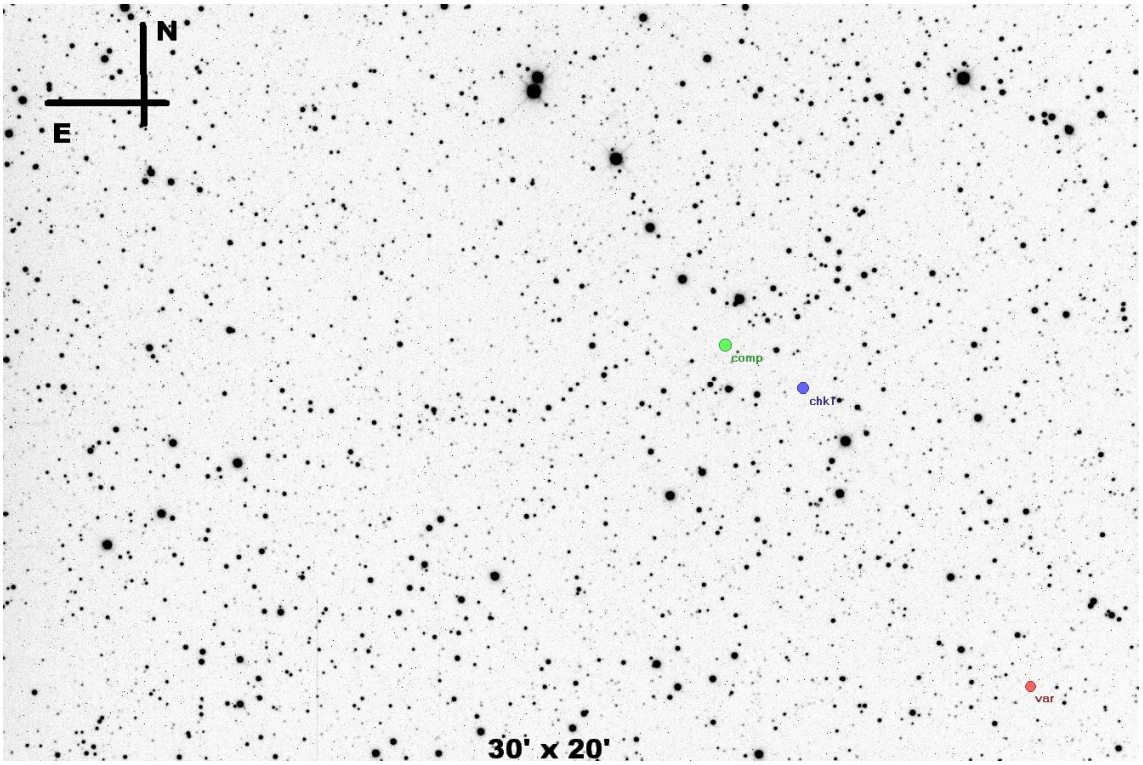

Fig. 5. Finding chart of the star HMB08 = USNO-B1.0 1035-0121640. The star is indicated by the red circle. Comparison star (green circle) and check star (blue circle) are also given.

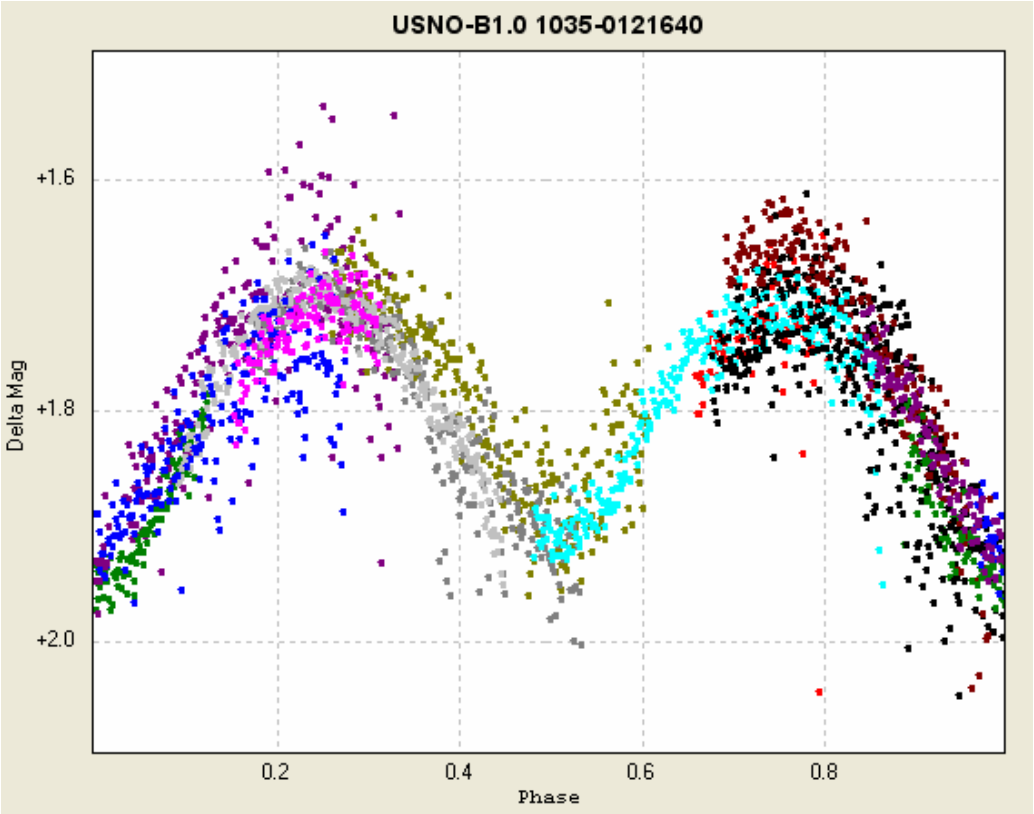

Fig. 6. Observed light curve segments of the star HMB08 = USNO-B1.0 1035-0121640. The different colors are for the different observing runs covering a period of 14 nights.

The International Variable Star Index Database (VSX) of the AAVSO **(AAVSO, 2006)** has been consulted and checked whether the three mentioned new variable stars are already known. This was not the case.
The following table gives a summary about the information on the newly detected variables:

Name	Magnitude	Delta-Mag.	Epoch (HJD)	Period [d]
HMB06	16.9 - 17.5	0.6 +/- 0.1	2454155.699	0.32667 +/- 0.00012
HMB07	14.55 - 15.05	0.45 +/- 0.05	2454155.683	0.53284 +/- 0.00017
HMB08	15.9 - 16.2	0.25 +/- 0.1	2454155.742	0.43257+/- 0.00024

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