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CCD OBSERVATIONS OF THE OPEN CLUSTER NGC6823 AND ASSOCIATED BRIGHT NEBULA NGC6820—FIRST RESULTS AND PROSPECTS OF THE UZBEK-TAIWAN COLLABORATION AT MAIDANAK

A. S. HOJAEV,[1] W. P. CHEN,[2,3] and H. T. LEE[2]

[1] *Ulugh Beg Astronomical Institute of the Uzbek Academy of Sciences 33, Astronomicheskaya, 700052,Tashkent, Uzbekistan*
[2] *Graduate Institute of Astronomy, National Central University Chung-Li,32054, Taiwan*
[3] *Department of Physics, National Central University Chung-Li,32054, Taiwan*

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Preliminary results of broadband and narrowband CCD imaging of the young star cluster NGC6823 and the associated bright nebula NGC 6820 are reported. The observations were made in August 2001 at Maidanak Observatory (Uzbekistan) as a collaborative initiative between the Graduate Institute of Astronomy of the National Central University of Taiwan (NCU), and Ulugh Beg Astronomical Institute of the Uzbek Academy of Sciences (UBAI). The two institutes, along with colleagues from Lithuania and Latvia, are working together to modernize and instrument the existing telescope facilities at Maidanak to make use of the excellent astroclimate of the site. As a pilot project, we selected candidate young stars in NGC 6823, based on their 2MASS NIR colors and obtained their photometry with Maidanak telescopes. The youth nature of some of these sources were later confirmed by spectra taken by the 2.16 m telescope at Beijing Observatory. This demonstrates that combination of small telescopes and existing databases such as those of 2MASS and ROSAT/Chandra, can yield fruitful science. Other Uzbek-Taiwan collaborations in the planning are outlined.

KEY WORDS young stars, open clusters, international collaboration

1 INTRODUCTION

At present the only effective way to advance science in Uzbekistan, which has long tradition in astronomy, is through mutually beneficial international cooperation fostering the financial and intellectual resources of different countries. This will help Uzbek astronomers to continue their research, and at the same time provide

the international community telescope access to the facilities installed at Maidanak in Uzbekistan.

Known among the FSU astronomical community, Mt. Maidanak was slated as the best site for an astronomical observatory among about a few dozen tested in early 1960s. The reason was that within the FSU sovereignty the southern-western part of Central Asia was found to have the maximum number of clear nights, highest atmospheric stability, and least water vapor content in the air. Maidanak ($66^o56'$ E; $386^o41'$ N; H = 2600 m) is an isolated summit as part of the Pamir and Alay mountain range. A long-term astroclimatic exploration starting in 1969 indicated that Maidanak had excellent seeing conditions, typically at subarcsecond levels, sufficient number of clear nights, dark night sky, and good atmospheric transparency. It thus competes as one of the most preferable sites worldwide for ground-based astronomy. Latest tests with an ESO Differential Image Motion Monitor (also used for site testing in Chile) and a Generalized Seeing Monitor confirmed the previous conclusions (see, e.g., Ehgamberdiev et al., 2000, or visit the URL http://www.eso.org/gen-fac/pubs/astclim/espas/maidanak/).

The Observatory hosts about 10 telescopes, including a 1.5 m, a 1.0 m, and others with aperture sizes of 0.6 m or less. These telescopes, if appropriately equipped, together with the astroclimatic and longitudinal advantages of the site, will make Maidanak very competitive for astrophysical research, especially in high-angular-resolution imaging, and long-term monitoring programs via global telescope networking. The NCU, actively developing its own small-telescope facility in Taiwan, takes up the opportunity and teams up with the UBAI. Below we present the preliminary results of our study of the star cluster NGC 6823 and the associated bright H II region NGC 6820.

2 THE OBSERVATIONS AND PRELIMINARY RESULTS

Candidate young stars (T Tauri stars and Herbig Ae/Be stars), have been selected based on their 2MASS near-infrared colors (Lee & Chen 2002), in the general region in NGC 6820/6823 (Figure 1).

A total of 20 Herbig Ae/Be and 40 T Tauri candidates have been identified. Imaging observations were carried out at Maidanak Observatory in August 2001. Of the 10 nights of our observing run, 8 were perfectly clear and one was partially cloudy before a rainy day. The seeing was remarkable, sometimes as good as 0.3", with 0.6" average.

We used the 1.5 m and one of the 0.6 m telescopes. The Zeiss 0.6 m telescope was used for photometry imaging. A high sensitive (QE$\sim$90%) water-cooled CCD-camera, AP-8e, with an SITe SI-003AB 1024×1024 CCD (Apogee Technology Inc.), was used, with UBVRI, H-alpha, [O III] (500.7nm; passband 30nm) and [S II] (672.4nm doublet; passband 50nm) filters. For the NGC 6823 observations, the R and I filters were used. The entire NGC 6820/6823 region was surveyed by mosaicing.

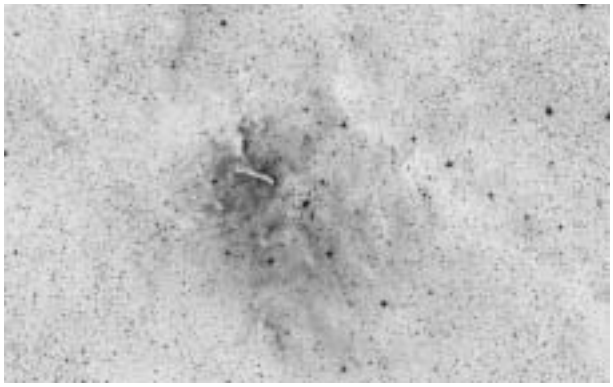

Figure 1 The DSS red image of NGC 6820 and NGC 6823.

Table 1. New found young stars in NGC 6820/6823

Number	*R.A. (2000)*	*Decl. (2000)*	*Type*	*J*	*H*	*Ks*
1	19 42 27.92	+23 05 14.7	CTTS	11.047	10.275	09.689
2	19 42 54.99	+23 24 14.8	CTTS	10.343	09.333	08.404
3	19 42 57.68	+23 22 52.1	CTTS	12.955	12.213	11.622
4	19 43 04.40	+23 18 48.7	HAeBe	11.579	10.515	09.601
5	19 43 07.51	+23 26 02.9	HAeBe	12.753	11.811	10.970
6	19 43 08.59	+23 25 45.7	HAeBe	13.595	12.784	12.066
7	19 43 10.17	+23 25 31.1	HAeBe	13.558	12.304	11.381
8	19 43 20.99	+23 19 02.3	HAeBe	13.057	11.557	10.355

The 1.5 m AZT-22 telescope (LOMO, Russia), with nearly diffraction-limited optics and careful thermostabilization, allows for high-angular-resolution imaging. It is equipped with a professional LN-cooled CCD-camera, with an SITe-005 2000×800 CCD (Copenhagen University Observatory, Denmark), provided by the Maidanak Foundation and equipped with standard Johnson UBVRI as well as a narrow-band H-alpha (656.3nm; 30nm passband) filters. For our NGC 6823 observations, the 1.5 m telescope was used in H-alpha for small regions that called for careful examination in the images taken by the 0.6 m telescope.

Some of the young star candidates were observed in October 2001 and again in February 2002 with the spectrometer on the 2.16 m telescope of Beijing Observatory in China. Both low-dispersion (200Å/mm, 1.2Å/pixel and 2.5' slit) and higher-dispersion (50 Å/mm) spectra were obtained. Eight sources have been found to show H-alpha emission in their spectra, of which 5 are probable Herbig Ae/Be stars (HAEBE), and 3 are probable classic T Tauri stars (CTTS). Figure 2 shows typical low-resolution spectra of an early-type and a late-type young star, respectively, thus identified. These young star candidates, and their 2MASS magnitudes, are summarized in Table 1.

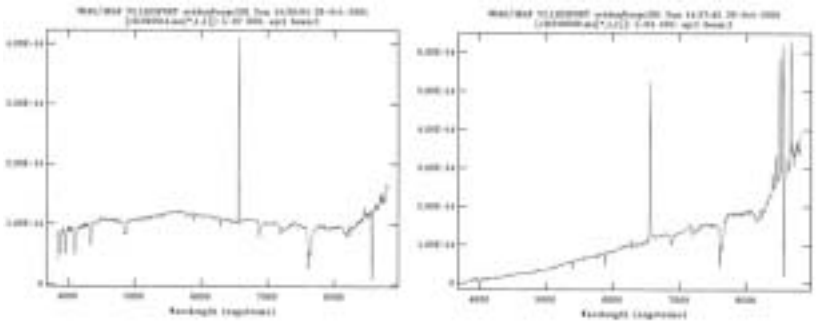

Figure 2 The low-resolution spectra of (left) an early-type and (right) a late-type young star, respectively.

3 CURRENT AND FURTHER PLANS OF COLLABORATION

The collaboration between the NCU and the UBAI was initiated in January 2001 during an IAU colloquium on small-telescope astronomy held in Kenting, Taiwan. In the subsequent summer a Taiwanese team visited the UBAI in Tashkent and observed at the Maidanak Observatory jointly with colleagues from Uzbekistan. The visit to Maidanak concluded with the impression of the good sky conditions and the lack of proper instrumentation at the site. An immediate solution would be to renovate existing facilities.

A Memorandum on Scientific and Technical Collaboration was signed in early 2002 between the two institutions. Our collaboration now has extended to include Latvia, Lithuania and Chinese astronomers, initially for open cluster research and later to include variable star studies. Recently the NCU team installed a 1-m telescope at Lulin Observatory in Taiwan. It will become part of a consortium to include other small telescopes (e.g., Maidanak, Yunnan) for global time variability monitoring, or for complementary observations (e.g., the Moletai 1.65 m or the Beijing 2 m for spectroscopy). In the future this network will expand to take part in global variability monitoring campaigns, e.g., for asteroseismology, search of extrasolar planets or monitoring X-ray binaries, etc. Our pilot project on NGC 6820/23 demonstrates the effectiveness of combining databases (2MASS, ROSAT or Chandra) and small-telescope observations (imaging photometry and spectroscopy) for a comprehensive study of a targeted star-forming region. A two-year grant has recently been awarded, under the Taiwan-Baltic Foundation, to reinforce the scientific interaction among these institutions. We foresee scholar and student exchanges, joint workshop conferences, instrumentation development, and other research ventures.

Our first endeavor, together with colleagues in Lithuania (Institute of Theoretical Physics and Astronomy of Lithuania and Vilnius University) and Latvia (IAPS

and University of Latvia), is to bring the Maidanak 1 m up to modern standards. An upgrade plan includes the following items: (1) Computer control of the pointing and tracking, with sky chart (Sky/GSC/DSS) interface, and with display and analysis for all telescope status indicators. The user can click on a particular object on a chart and the telescope will slew to it. Autoguiding will be available for long exposures. (2) Computer control focusing. (3) Synchronized dome. The slit of the dome automatically follows where the telescope is pointing, possibly with an innovative ultrasonic sensor. (4) Realization of an enlarged field of view with corrector optics in conformance to the future CCD camera. (5) Mirror cleaning apparatus. (6) A new state-of-the-art professional CCD camera. (7) A suite of filters (broad and narrow bands).

Part of the upgrade engineering, scheduled to begin in the fall of 2002, will be made by a Chinese group who have successfully upgraded an identical telescope of Yunnan Observatory in China. Instrumentation development will be our next major step, especially IR cameras for imaging and low-resolution spectroscopy, for which new partners are very encouraged.

4 CONCLUSIONS

This paper presents the initial scientific and technical efforts of a collaboration among Uzbekistan, Taiwan and Baltic astronomers, to make use of the facilities at Maidanak Observatory. CCD observations of NGC 6820/6823 carried out at Maidanak, together with data of 2MASS and ROSAT/Chandra databases, allowed us to identify candidate young stars, whose youth nature has been confirmed by spectroscopy done with the Beijing 2.16 m telescope. This clearly demonstrates that combination of small telescopes and existing databases, can yield fruitful science. We are taking the first step to bring the Maidanak 1 meter up to modern standards, as part of our effort of a consortium of Uzbek, Taiwanese, and Baltic astronomers for long-term scientific and technical collaboration.

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References

Ehgamberdiev, Sh. A. et al. (2000) *Astron. and Astrophys., Suppl.*, **145**, 293.
Lee, H, T, and Chen, W. P. (2002), *8th IAU Asian-Pacific Rim Meeting Proceedings*, **Tokyo**, 111