DEVELOPMENT OF LONG-SLIT SPECTROGRAPH FOR A SMALL TELESCOPE: SPECTROSCOPIC OBSERVATIONS OF COMETS BY AMATEUR ASTRONOMERS. Hideyo Kawakita[1], Tomoyasu Yamamuro[2], Tomoyo Kajikawa[3]. [1]Kyoto-Nijikoubou Co., 23-1-402, Nishikujo-Nanden, Minami-ku, Kyoto 601-8441 (kawakita@kyoto-nijikoubou.com), [2]OptCraft Co., 3-16-8-101, Higashi-Hashimoto, Midori-ku, Sagamihara 252-0144, Japan, [3]Department of Physics, Faculty of Science, Kyoto Sangyo University Motoyama, Kamigamo, Kita-ku, Kyoto 603-8555, Japan.

Introduction: Spectroscopic observations of comets can reveal the chemical composition of their comae. Especially, in optical wavelength region more than one hundred of comets have been observed by spectroscopic or spectro-photometric surveys [1–6]. In the optical wavelength region, radicals and atoms are observed by their emission lines: e.g., CN, C_3, C_2, NH_2, [OI], Na. Although these are not parent molecules (directly incorporated in cometary ices) but fragments of those parent molecules, mixing ratios of those radicals with respect to H_2O are clue to chemistry of comets. Based on taxonomic studies about chemical composition of cometary radicals, several taxonomic classes have been proposed [2–4]. One of the peculiar comet classes is a carbon-poor comet that is strongly depleted in CN, C_2 and probably also in C_3 [1–3]. The origin of those comets were still unclear. They might not form in our solar system. If these comets formed in our solar nebula, we have to explain wide variety in chemistry of ices in the solar nebula. In order to investigate the origin of those comets, high-dispersion spectroscopic studies to reveal isotropic ratios (e.g., D/H, $^{12}C/^{13}C$, $^{14}N/^{15}N$ ratios) are essentially important. To inspire such observations, we have to find the candidates as soon as possible by the low-dispersion spectroscopic survey in optical. For this purpose, large telescopes are not necessary. Monitoring observations of many comets newly discovered could be possible by smaller telescopes with highly efficient low-dispersion spectrographs. Here we introduce our new instrument optimized to comet observations.

Specifications and Design: The 28cm-telescope (F/10) is our target because such telescopes can be easily obtained from many telescope-makers. For comet observations, we considered the followings are required for the spectrograph:

(i) a wide and long slit (10 arcsec x 20 arcmin),
(ii) high throughput for the optics (>30% at max),
(iii) a spectral resolving power higher than 500 at 630 nm,
(iv) capability to view the slit during exposure
(v) equipped with a calibration lamp.

The first requirement is especially important for comets. Wider and longer slit can collect more photons from a comet. In order to efficient observations, more photons (as (i)) and higher throughput (as (ii)) are necessary for small telescopes. Longer slit is also important for the simultaneous observations of sky background with a comet (to achieve accurate sky subtraction). Spectral resolving power is chosen to separate [OI] emission lines (at 630 and 636.4 mm) from NH_2 (0,8,0) band peak at ~633 nm to derive water production rate from [OI] emission accurately. Moreover, we usually have to guide a comet during exposure, so we need the slit-viewing camera.

Figure 1 shows our prototype spectrograph. The physical dimensions of the spectrograph are 18 x 11 x 9 cm. High throughput of the spectrograph (without CCD camera) is confirmed by the observations of spectro-photometric standard star, higher than 30 % in the wavelength range from 450 to 650 nm.

Future plan: Our spectrograph is suitable for comet observations by using small telescopes. If many amateur astronomers would use this type of spectrograph, newly discovered comets and rare phenomena like a super-outburst of comet 17P/Holmes in 2007 can be monitored continuously. We hope our spectrograph is helpful to discover new chemically peculiar comets in future.

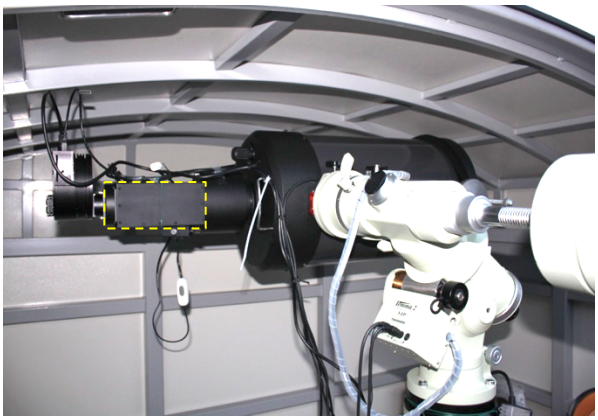

Figure 1: Prototype of our spectrograph attached with a 28cm-telescope, within a dashed-line box. An electric-cooled CCD camera (ST-8i, SBIG) was used as a detector (left side of the spectrograph).

Reference:

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