VERY STRONG SODIUM EMISSION LINE OBSERVED IN COMET MCNAUGHT (C/2006 P1) SPECTRUM

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ABSTRACT

A very strong Sodium (Na I) emission line was recorded in comet McNaught (C/2006 P1) spectrum during the perihelion passage of the comet. Although references of Na line emission in comets spectra can be found in bibliography, this is probably the first time that such a strong Na emission line has been recorded. In this paper, the equipment and the method of recording the comet's spectrum is described, together with the calculation of the relative intensity of the Na emission line to the continuum spectrum.

On January 10, 2007, at 15:50 UT, a strong Sodium (Na I) emission line was recorded in comet McNaught (C/2006 P1) coma, which was then at a perihelion (comet's heliocentric distance 0.206 AU). The observation took place in Livadi (35Km East from Thessaloniki, Greece, latitude 40° 30' 58,26" N , lognitude 23° 10' 41,93" E and high 372m above sea level).

A digital SLR camera adapted to a low dispersion spectrograph (hand made by the author), for recording the spectrum, with the following specifications: 100 line/mm transmission grating, 20 μm slit width and a resolution of 8 Å/pixel. A Carl Zeiss telephoto lens (180 mm, f/2.8) was used to project the comet's light at the spectrograph's slit. The setup of the reflecting slit during the recording of the spectrum enabled the simultaneous aiming and driving of the optical system (spectrograph and telephoto lens).

The recording took place in twilight, 30 minutes after sunset. As a result, characteristic Fraunhofer absorption lines from the solar spectrum were also recorded, together with terrestrial absorption lines from water vapor and oxygen in Earth's atmosphere. A continuous (solar) spectrum can be observed in the position corresponding to the bright coma, much brighter than the daylight spectrum, which is generated by the reflection and dispersion of sunlight from the comet's nucleus and coma dust particles, and also a very strong yellow emission line (fig.2,B). Mercury (Hg) and Sodium (Na) vapor lamps were used in daylight for the calibration of the instrument. The analysis showed that at the position of the dark absorption lines of Na (Fraunhofer) in the daylight (solar) spectrum, a strong emission line from Na I was recorded, corresponding to D_1+D_2 D_1= 5890 Å, D_2=5896 Å (the strong yellow emission line was exactly

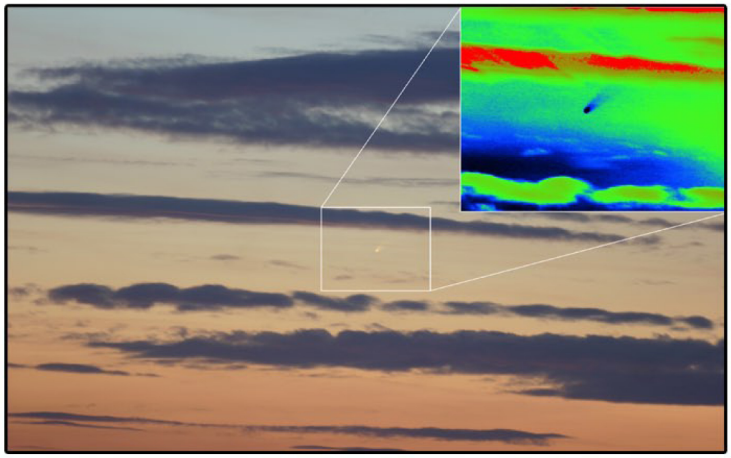

Figure 1: Comet McNaught (C/2006 P1), on January 8, 2007 at 16:55 UT. A bright coma and its tail can be seen. Up right coner the comet McNaught in false color.

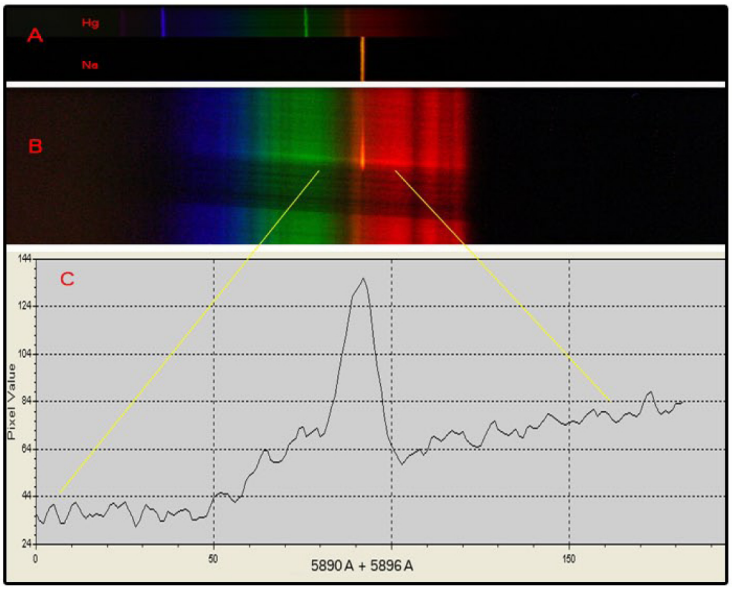

Figure 2: Comet McNaught's spectrum recorded on January 10, 2007, at 15:50 UT. A) Calibration spectrum using Hg and Na vapor lamps. B) The strong Na line emission in the comet's spectrum, together with the daylight spectrum background.
Within the spectrum, a solar continuum can be seen, stemming from reflection and diffusion of solar light in the nucleus and coma. C) A cut through the spectrum of the comet, showing the Na line emission together with the daylight solar spectrum.

coincident with the Na vapor lamp emission).The strength of the emission line (D_1+D_2) from the comet's spectrum is six times (6σ) stronger relative to the background (daylight spectrum + comet's continuum) (fig.2,C). After subtracting the daylight spectrum, the intensity of the Na emission line (fig.3,D) is more than eleven times (11,55σ) stronger than the comet's continuous spectrum (fig.3,E), meaning that the comet is strongly yellow tinted, due to the emission of excited Na atoms.

The same emission line was also recorded (fig.4) on January 11, 2007 at 16:55 UT (comet's heliocentric distance 0,17 AU), using a different spectrograph, also constructed by the author, with a 600-line/mm reflecting grating and a long slit width of 1 mm (1000 μm) i.e. almost slit-less spectrograph.

On January 13, 2007 at 16:43 UT (comet's heliocentric distance 0,18 AU), using the first spectrograph, a medium intensity Na emission line was recorded, which was about 3 times stronger relative to the background (daylight spectrum + comet's continuum) and 7 times (7σ) stronger than the continuum spectrum of the comet (fig.5).

On January 14, 2007, (comet's heliocentric distance 0,19 AU) however, no Na line emission was recorded.

The bibliography gives a reference for the line emission from Na atoms in comet's spectra, but not as strong as the one recorded in comet's McNaught spectrum on January 10 2007. A rich in Na tail was observed in comet Hale - Bopp[1] [2]. A decrease in the relative intensity of the Na emission line to the comet's continuous spectrum was recorded at the time of perihelion passage for Hale - Bopp[3] (as a result of the Swings effect). Furthermore, Na emission was detected in comet Mrkos' head at the time of its perihelion passage[4].

This is clearly also the case for comet McNaught 2006 P1, since the observed Na emission line is connected with its perihelion passage. Absorbing a large amount of solar radiation, Na atoms were excited, either directly by the Sun's heat or by fluorescence[5].On the other hand, no Na line emission showed up in spectroscopic analysis of periodic comet Encke[6]. A possible explanation is that due to the frequent perihelion passages of the comet, most of it sublimated.

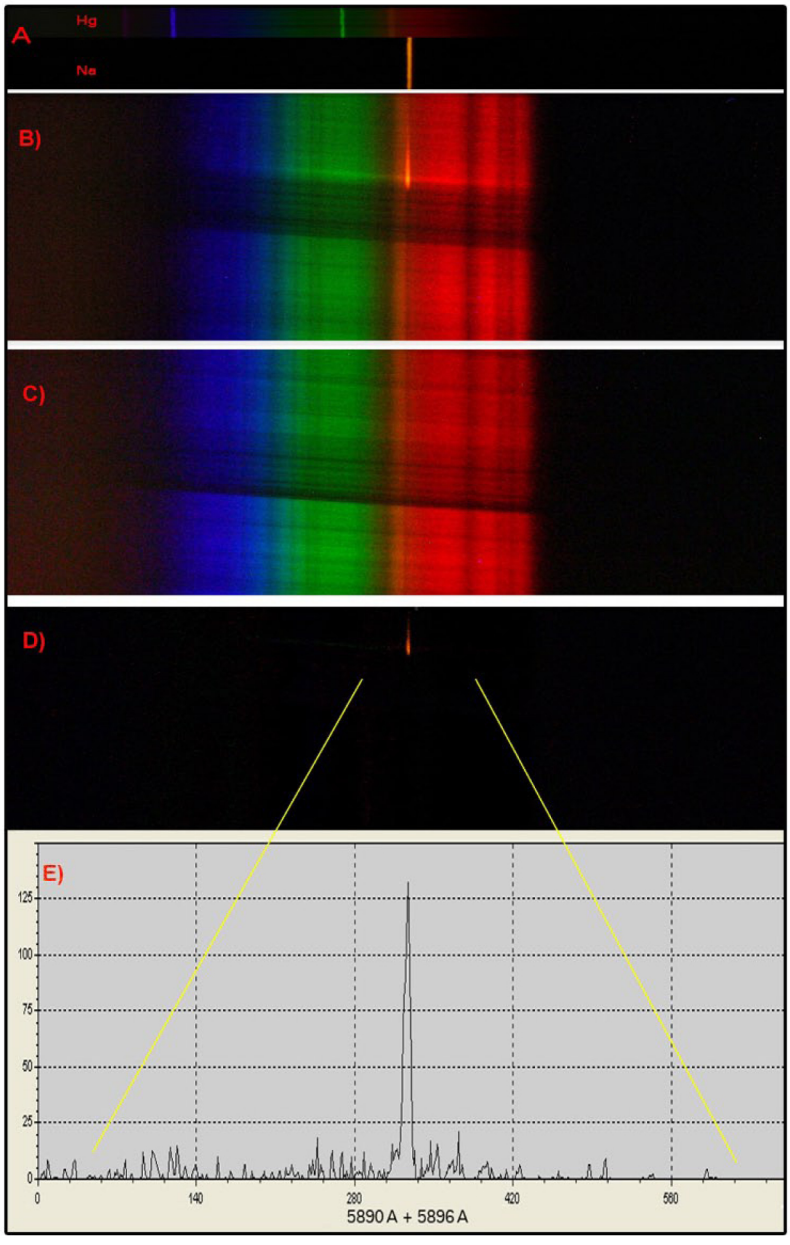

Figure 3: Comet McNaught's spectrum recorded on January 10, 2007, at 15:50 UT A) Calibration spectrum using Hg and Na vapor lamps. B) The strong Na line emission in the comet's spectrum, together with the daylight spectrum background.
Within the spectrum, a continuum can be seen, stemming from reflection and diffusion of solar light in the nucleus and coma. C) Daylight spectrum (solar spectrum) recorded by dispersion of sunlight in the Earth's atmosphere, without projecting the comet in the slit of the spectrograph. D) Digitally subtracting image C from B (B-C) , eliminates the background spectrum. E) A cut through the spectrum, after the subtraction. The emitted light in the Na line emission is more than eleven times stronger than the reflected sunlight in the comet's nucleus and coma.

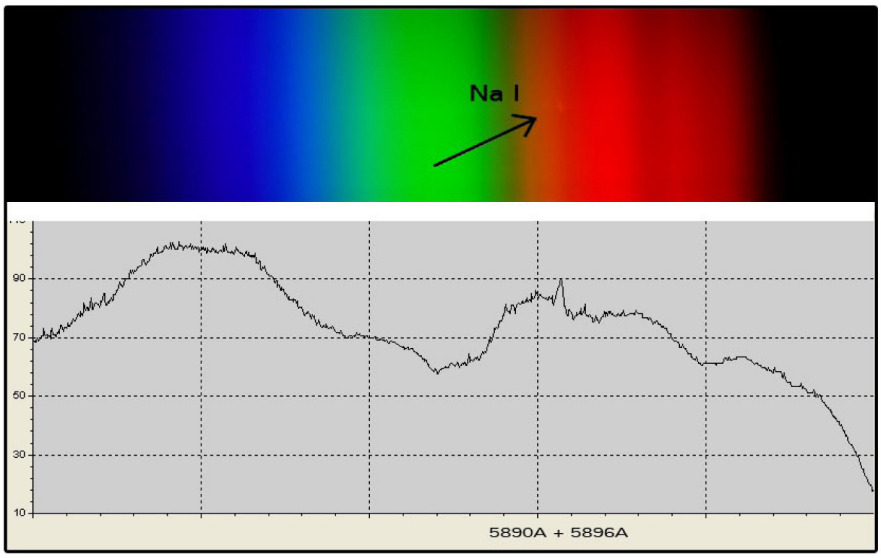

Figure 4: The comet's Na emission (shown with the arrow) on January 11, 2007, at 16:55 UT, recorded with the second spectrograph, having a slit width of 1 mm, shows the strong emission Na line.

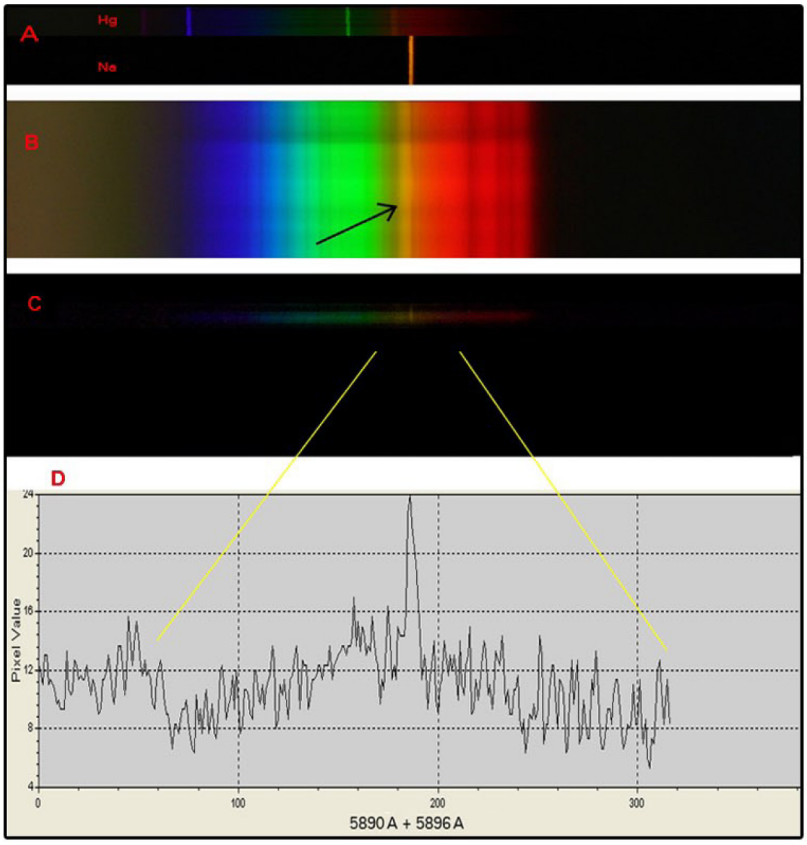

Figure 5: The comet's spectrum on January 13, 2007, at 16:43 UT. A) Calibration spectrum using Hg and Na vapor lamps. B) A medium intensity emission line of Na (interrupting the absorption line $D_{1,2}$ of the Sun spectrum). D) A cut through the spectrum C, (after the digitally subtraction of the daylight solar spectrum). The intensity of the Na line emission is seven times stronger than the comet's continuum spectrum.

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