

# DETECTION AND STUDY OF LUMINESCENCE COMETARY CONTINUUM IN SPECTRA OF COMETS SCHAUMASSE (24P), SCORITCHENKO-GEORGE (C/1989 Y1) AND HALE-BOPP (C/1995 O1)

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**ABSTRACT.** The authors investigated spectra of four comets with the aim to determine the real level of the non-solar origin continuum in the spectral region 350-500 nm. Spectra of three comets Schaumasse (24P), Scoritchenko-George (C/1989 Y1) and Hale-Bopp (C/1995 O1) were observed with the help of the 6-m BTA telescope and the spectrograph with the long slit at the Special Astrophysical Observatory of the Russian Academy of Sciences. Spectra of two comets Hyakutake (C/1996 B2) and Hale-Bopp (C/1995 O1) were obtained with the 1-meter Zeiss telescope and echelle-spectrometer of the SAO RAS. As a result of processing the cometary spectra we obtained: 1) For comet Schaumasse (24P) March 14-15, 1993 the level of the non-solar-origin continuum equal to 44 per cent of the sum continuum level at 430 nm; 2) For comet Scoritchenko-George (C/1989 Y1) February 27, 1990 the level of the non-solar-origin continuum equal to 40 per cent of the sum continuum level at 387 nm, 68 per cent - at 430 nm (max) and 23 per cent - at 480 nm; 3) 2) For comet Hale-Bopp (C/1995 O1) April 17, 1997 the level of the non-solar-origin continuum equal to 32 per cent of the sum continuum level at 397 nm and 77 per cent - at 438 nm; 4) For comet Hyakutake (C/1996 B2) March 25, 1996 the continuum of the non-solar origin was not detected. We suppose that in spectra of comets Schaumasse (24P), Scoritchenko-George (C/1989 Y1) and Hale-Bopp (C/1995 O1) we detected the real cometary continuum tied with the luminescence of the comet organic spices which are in comet dust particles.

**Key words:** comet, spectrum, continuum, luminescence.

## 1. Introduction

For the first time the luminescence continuum of the cometary dust was discovered in a spectrum of comet

Halley by G. Nazarchuk (1987a;1987b). However, up to this day the existence of this effect has been discussed. The authors investigated of spectra of several comets and showed independently that this effect took place really at observations of comets with big telescopes having high space and spectral resolution. Below results of search of luminescence cometary continuum for 4 comets are given.

## 2. Comet Schaumasse (24P)

Spectra of comet Schaumasse (24P) were obtained March 14/15, 1993 with the CCD-scanner installed on 6-m BTA reflector of the Special astrophysical observatory of the RAS (Churyumov and Kleshchonok, 1994). Observations were held using the slit with the sizes 2" x 1'. Altogether three spectra of the comet in the spectral range 370-600 nm with the quantity 0.2 nm were obtained. The spectral resolution was 0.4 nm. Peculiarity of the comet is anomaly big relation  $Q(C_3)/Q(CN)$  equal to 0.94. This is approximately four times bigger than for the "normal" comet. Authors studied a range of the solar spectra near the intensive Fraunhofer line G. This line is almost unseen in the cometary spectrum though only a cometary continuum and the weak lines of the CH radical are present in this range of the cometary spectrum. Then the solar spectrum was compared with the cometary spectrum divided on the solar spectrum. This procedure is made in order to receive the parameters of the particles scattered light in the cometary atmosphere. The obtained curve has a very strong anticorrelation with the solar spectrum. This indicates the presence of luminescence of the cometary dust. It is this effect that must lead to decrease in the depths of the Fraunhofer lines in the cometary spectra. Luminescence of dust is clearly seen in the violet range of the spectrum and not substantial

in more longwave range (470-570 nm) of one.

### 3. Comet Scritchenko-George (C/1989 Y1)

The spectra of comet Scritchenko-George (C/1989 Y1) were obtained Feb. 27.6 UT, 1990 with the 6-m BTA reflector of the Special Astrophysical Observatory of the RAS using the TV-scanner, installed in the focus of Nasmith. Record of the spectra were made in three spectral ranges: 335-445 nm, 429-539 nm and 529-639 nm. The spectral resolution of the obtained spectra is 0.2-0.4 nm. From the observations of the standard star in the same spectral ranges a relative intensity of radiation in the cometary spectrum was determined. All the spectra were reduced to the standard step 0.1 nm. Further record from the central region of the coma were combined in one spectrum.

In this cometary spectrum as well as in the spectrum of comet Schaumasse, the effect of luminescence of the cometary dust was also detected. In order to determine its contribution the following technique was used. The solar spectrum for the particular spectrograph was calculated by convolution of the initial spectrum of the Sun with the high resolution and function of the response of the spectrograph which was approximated by the function of the type

$$0.5 \cdot \exp(-|\lambda - \lambda_c| \setminus \delta\lambda)$$

where  $\delta\lambda$  - the spectral resolution of the spectrograph.

For strong absorption lines in the solar spectrum (in the absence of strong emissions in the cometary spectrum in this spectral range) the additional value  $i_f$  which was selected so to equalize the values of the contrast of the selected Fraunhofer line in the solar and cometary spectra:

$$\frac{i_o^c - i_f^c}{i_l^c - i_f^c} = \frac{i_o^s}{i_l^s}$$

where  $i_o$  is the intensity level of the solar continuum spectrum close to the line,  $i_l$  - the intensity level of the spectrum in the center of the Fraunhofer line, indices  $c$  and  $s$  are related to the spectra of the comet and the Sun respectively. The value  $i_f$  thus determined was taken as the intensity level of the luminescence continuum of the cometary dust.

Because strong Fraunhofer lines were selected, the result is almost weak dependence from the inaccuracy in selecting the function of the spectrograph's response. Fig.1 shows the range of the spectrum where substantial contribution of the luminescence continuum was observed. The filled circles mark the values  $i_f$ , obtained by the formula and the dashed curve marks approximation of the luminescence continuum, determined using these circles.

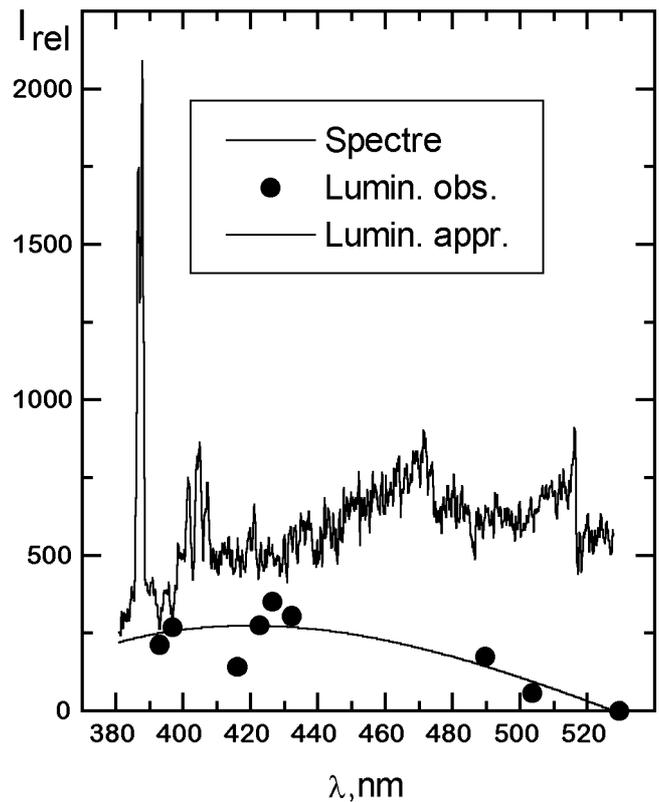


Figure 1: The range of the spectrum of comet Scritchenko-George in which the luminescence continuum was detected.

### 4. Comet Hale-Bopp (C/1995 O1)

Spectra of the bright comet Hale-Bopp were obtained on 6-m telescope (SAO of RAS) with the UAGS spectrograph and CCD-camera in the prime focus of the telescope (Churyumov et al., 1997). In observations the diffraction grating which gives dispersion nearby 0.3 nm per pixel and spectral resolution 0.5-0.6 nm was used. The scale of images along the slit (perpendicular to dispersion) is 0.41" per pixel. For determination of intensity of the emission lines subtraction of the solar spectrum was made. In places of the strong lines of the absorption of H and K of  $Ca^+$  of the Fraunhofer spectrum inversion is observed - absorption lines are converted in emission lines analogous to observations of Nazarchuk (1987a; 1987b) in comet Halley (1P) and authors in comets Schaumasse and Scritchenko-George (see above). Comet Hale-Bopp was also observed with the high spectral resolution on the 1-m Zeiss reflector of the SAO of the RAS (Churyumov et al., 1999). In observations the echelle-spectrometer installed in the Coude-focus was used, and during Apr. 17-19, 1997, five spectra of the comet (the comet's heliocentric distances  $\Delta = 0.96 - 0.97$  A.U.) were obtained. As the results of processing of the spectra contributions of the solar and luminescence continuum in

common cometary spectrum in different spectral ranges were determined: a) 77 and 23 per cent respectively for the spectral range 4370 - 4390 ÅÅ ; b) 68 and 32 per cent for 3960-3980 ÅÅ ; c) 100 and 0 per cent for 4920-4940 ÅÅ ; d) 100 and 0 per cent for 5490-5510 ÅÅ . We think that the cometary continuum of the non-solar origin for the spectral ranges 4370 - 4390 ÅÅ and 3960-3980 ÅÅ was detected.

#### 4. Comet Hyakutake (C/1996 B2)

Comet Hyakutake (C/1996 B2) was observed March 23, 1996 with the high spectral resolution on the 1-m Zeiss reflector of the SAO of the RAS. In observations the echelle-spectrometer installed in the Coude-focus with the spectral resolution  $\lambda/\delta\lambda \approx 50000$  was used. Record of the spectrum were made with the CCD-camera. After preliminary processing a search of the luminescence continuum according to the above mentioned technique was undertaken. However in this case for all spectral ranges the continuum intensity level was less 8 per cent that is less than the values of the errors of its determination. Thus in comet Hyakutake the luminescence radiation of the cometary dust was not detected or it is on the level of errors of observation.

#### 4. Conclusion

1) For comet Schaumasse (24P) March 14-15, 1993 the level of the non-solar-origin continuum equal to 44 per cent of the sum continuum level at 430 nm;

2) For comet Scritchenco-George (C/1989 Y1) February 27 , 1990 the level of the non-solar-origin continuum equal to 40 per cent of the sum continuum level at 387 nm, 68 per cent - at 430 nm (max) and 23 per cent - at 480 nm;

3) For comet Hale-Bopp (C/1995 O1) on April 17 , 1997 the level of the non-solar-origin continuum equal to 32 per cent of the sum continuum level at 397 nm and 77 per cent - at 438 nm;

4) For comet Hyakutake (C/1996 B2) March 25, 1996 the continuum of the non-solar origin was not detected.

We suppose that in spectra of comets Schaumasse (24P), Scritchenco-George (C/1989 Y1) and Hale-Bopp (C/1995 O1) we detected the real cometary continuum tied with the luminescence of the comet organic spices which are in comet dust particles.

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