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Physical parameters of gaseous and dust atmospheres of three comets 9P/Tempel 1, 37P/Forbes and C2004 Q1 (Machholz)

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One of three explored comets 9P/Tempel 1 was the main target of space mission Deep Impact. We present the results of exploration of spectra of three comets 9P (Tempel 1), C2004 Q1 (Machholz) and 37P/Forbes observed in 2004-2005 at Observatorio do Pico dos Dias (Brazil) and at Mount Pastukhov and Peak Terskol (Russia). The detailed identification of emission lines in spectra of comet 37P/Forbes was made. BVRI photometry comets 9P /Tempel 1) and C2004 Q1 (Machholz) was carried out. Physical parameters of C_2, C_3 and CN gases in the near nucleus region of the cometary atmospheres of comets 9P (Tempel 1), C2004 Q1 (Machholz) and 37P/Forbes were determined. Presence of cometary luminescence continuum (non-solar origin) in the spectra of three comets are confirmed.

ФІЗИЧНІ ПАРАМЕТРИ ГАЗОВИХ ТА ПИЛОВИХ АТМОСФЕР ТРЬОХ КОМЕТ 9P/Tempel 1, 37P/FORBESI C2004 Q1 (MACHHOLZ), Чурюмов К., Афанас'єв В., Пікаццiо Е., Клещенок В., Лук'яник І., Пономаренко В., Баранський О., Альмейда А., Коста Р., Чубко Л. — Одна з трьох досліджуваних комет 9P/Tempel 1 був головною ціллю космічної місії Діп Імпект в 2005 р. Ми представляємо результати дослідження комет 9P/Tempel 1, 37P/Forbes і C2004 Q1 (Machholz), які спостерігалися в 2004-2005 рр на обсерваторіях Пік Діас (Бразилія), на горі Пастухові (Росія) і піку Терскол (Росія). Проведено детальне ототожнення емісійних ліній в спектрі комети 37P/Форбса, BVRI фотометрію комет 9P /Tempel 1) і C2004 Q1 (Machholz). Розраховано фізичні параметри C_2, C_3 і CN газів в навколоядерних ділянках атмосфер комет 9P/Tempel 1, 37P/Forbes і C2004 Q1 (Machholz). Присутність кометного люмінесцентного континууму (не сонячного походження) в спектрах цих трьох комет підтверджується.

ФИЗИЧЕСКИЕ ПАРАМЕТРЫ ГАЗОВЫХ И ПЫЛЕВЫХ АТМОСФЕР ТРЕХ КОМЕТ 9P/Tempel 1, 37P/FORBES И C2004 Q1 (MACHHOLZ). Чурюмов К., Афанасьев В., Пикаццио Э., Клещенок В., Лукьяник И., Пономаренко В., Баранский А., Альмейда А., Коста Р., Чубко Л. — Одна из трех исследуемых комет 9P/Tempel 1 была главной целью космической миссии Діп Импект в 2005 г. Мы представляем результаты исследования комет 9P/Tempel 1, 37P/Forbes и C2004 Q1 (Machholz), которые наблюдались в 2004-2005 гг на обсерваториях Пик Диас (Бразилия), на горе Пастухова (Россия) и пике Терскол (Россия). Проведено детальное отождествление эмиссионных линий в спектре кометы 37P/Форбса, BVRI фотометрию комет 9P /Tempel 1) и C2004 Q1 (Machholz). Рассчитаны физические параметры C_2, C_3 и CN газов в околоядерных участках атмосфер комет 9P/Tempel 1, 37P/Forbes и C2004 Q1 (Machholz). Присутствие кометного люминесцентного континуума (не солнечного происхождения) в спектрах этих трех комет подтверждается.

1. INTRODUCTION

High and middle-resolution optical comet spectra obtained with long slit allow to calculate some physical parameters of cometary neutral atmospheres (escaping velocities of gas in coma, life time of particles et other), search for new cometary emission lines, to estimate parameters of gas and dust productivity of comet nucleus, to detect the cometary luminescence continuum of the non-solar nature and other [3–10].

2. OBSERVATIONS AND PROCESSING OF COMETARY SPECTRA

The spectra of two well known short period comets 9P/Tempel 1 and 37P/Forbes observed at Observatório do Pico dos Dias (LNA — Laboratório Nacional de Astrofisica), Brasópolis (Brazil), in the course of 3–5 July, 2005. Observers are R.D.D.Costa and Andre Escudero. Helio- and geocentric distances of the comets r and Δ and their magnitudes m_1 were on July 3–5, 2005: for comet 9P/Tempel 1: $r = 1.51$ AU, $\Delta = 0.89$ AU, $m_1 = 9.9^m$ and for comet 37P/Forbes: $r = 1.60$ AU, $\Delta = 0.68$ AU, $m_1 = 12^m$.

Spectroscopic observations of comets 9P/Tempel 1 and 37P/Forbes were made on July 3–5, 2005 with the help of the Cassegrain spectrograph, using a 900/500 grating, attached to the Perkin & Elmer 1.6-m

Table 1. Observational data for comets 9P/Tempel 1 and C/2004 Q2 (Machholz)

Date & Time, UT	r, AU	Δ, AU	Time of exposure, sec	Phase angle	Comet
2004-Dec-18 21:15	1.33	0.43	3600	30	C/2004 Q2
2005-Mar-15 21:56	1.85	0.91	600	14.6	9P
2005-Mar-15 20:56	1.43	0.92	600	43.7	C/2004Q2

telescope of LNA. Spectral range: $\sim 374-526$ nm. Scales: 0.077355 nm/pix or 0.177 arcsec/pix. The spectrograph slit was oriented to the East-West direction.

The short period comet 9P/Tempel 1 was observed with SCORPIO installed in the Prime Focus of the 6-m telescope of the Special Astrophysical Observatory of the RAS on March 14–16, 2005 (Mount Pastukhov, Nizhny Arkhyz, Northern Caucase, Russia) by L.S.Chubko, K.I.Churyumov and V.L.Afanasiev (fig.1). The observations were obtained 2.5 months before collision of the copper impactor of the Deep Impact spacecraft with the SCORPIO (Spectra Camera with Optical Reducer for Photometrical and Interferometrical Observations). During the same nights they observed also spectra of new comet C/2004 Q2 (Machholz) (Fig.2). Alltogether were obtained 4 spectra of comet C/2004 Q2 (Machholz) and two spectra of comet 9P/Tempel 1. The focal reducer SCORPIO was used with long-slit (length of the slit is 2 arcmin, width of one is 1 arcsec).

Earlier 2 spectra of comet C/2004 Q2 (Machholz) were obtained during the night on 17–18 Dec. 2004 also with the help of the 6m telescope of the Special Astrophysical Observatory of RAS and the MPFS spectrograph by L.S.Chubko, K.I.Churyumov, V.Panchuk and M.Yushkin. The Spectrograph is intended for 2D spectrophotometry of the extended objects with medium spectral resolution. Spectrograph is mounted in Prime Focus of the 6-m Telescope. Main optical parts of the spectrograph: enlarger lens, multi lens array, wide field spectrograph. Spectral range 3600–9600Å, dispersion $0.75-3.0$ nm/px. Observational data for comets C/2004 Q2 (Machholz) and 9P/Tempel 1 are given in Table 1.

3. PROCESSING OF SPECTRA OF COMETS (TEMPEL 1), C2004 Q1 (MACHHOLZ) AND 37P/FORBES

All CCD spectra of comets 9P (Tempel 1), C2004 Q1 (Machholz) and 37P/Forbes were processed with the help of the LONG-MIDAS and the Research System IDL computer programs allowing for reductions of the CCD bias level, cosmic ray particles, flatfielding, and night sky contribution (Figs. 1–3) The catalog of the spectral lines in comet De Vico-Swift [11] was used for identification of the emission lines in the spectra of comet 37P/Forbes. The result of identification of the emission lines in spectra of comet 37P/Forbes obtained on July 5, 2005 are given in the Table 2.

4. IDENTIFICATION OF EMISSION LINES IN SPECTRA OF THE NEAR NUCLEUS REGIONS OF COMET 37P (FORBES)

The following typical cometary lines were identified in the interval wave lengths 4446–4612Å: 35 of C_2, 12 of NH_2, unidentified lines were 33.

5. BVRI PHOTOMETRY OF COMETS 9P/TEMPEL 1, C/2004 Q2 (MACHHOLZ)

Comets Tempel 1 and Machholz were observed with the SCORPIO spectrograph through BVRI filters and were obtained the following results:

As are seen from Table 3 color $B-V=0.7$ for comet 9P and $B-V=0.1$ for comet Machholz. BVRI photometry of comet Tempel 1 and Machholz had shown that comet 9P has color as the Sun (a little redder than the Sun), but comet Machholz was bluer very much than the Sun.

6. PHYSICAL PARAMETERS OF COMETS 9P/TEMPEL 1, C/2004 Q2 (MACHHOLZ), 37P/FORBES

In order to determine some physical parameters of gaseous components of the neutral cometary atmosphere (the gas component expansion u and the lifetime of the particles τ) we built a photometric profiles for the C_2, C_3 and CN emission lines along slit for selected comets (Figs. 5-7) Then the obtained monochromatic profiles were processed by Shul'man's model. Within this model the surface brightness was determined by the following formulas

$$\lg\frac{I(\rho,\varphi+\pi)}{I(\rho,\varphi)}=1.72\frac{\rho}{r_{0C}}\sin\Theta_0\cos\varphi,\qquad \frac{1}{2}\lg\frac{I(\rho,\varphi+\pi)}{I(\rho,\varphi)}=\mathrm{const}+\lg\left[\frac{r_{0k}}{\rho}\int\limits_{\rho/r_{0k}}^{\infty}K_0(y)\,dy\right],$$

where $I(\rho,\varphi+\pi)$ and $I(\rho,\varphi)$ are brightness surface of emission line along slit, ρ,φ — polar coordinates on the picture plane with the polar axe directed to the Sun, $r_{0C}=2u^2/g$ — characteristic scale of the spheric

Table 2. Emissions lines in comet 37P/Forbes on July 4, 2005

4446.50	9.55000019	–	Unid
4449.89	8.10999966	–	Unid
4451.92	8.48999977	–	Unid
4453.95	4.48000002	4453.51	Unid
4456.66	7.50000000	4456.17	Unid
4458.02	5.44000006	4458.02	Unid
4460.05	7.42000008	4460.05	Unid
4462.08	4.51000023	4462.08	Unid
4465.46	6.67999983	4465.24	Unid
4468.17	5.48000002	4468.09	Unid
4470.20	3.84999990	4470.20	Unid
4473.59	8.55000019	4473.77	Unid
4476.97	7.44000006	4476.85	Unid
4479.01	3.74000001	4478.93	Unid
4480.36	7.40000010	4480.36	Unid
4481.71	7.53999996	4481.10	Unid
4483.74	8.56999969	4484.66	Unid
4485.10	8.26000023	4485.29	Unid
4487.81	8.64999962	4487.93	Unid
4489.84	6.61999989	4489.90	Unid
4492.54	10.31000042	4492.46	Unid
4495.25	6.44999981	4494.96	Unid
4497.96	7.42999983	4498.04	Unid
4499.99	8.40999985	4500.16	Unid
4502.02	9.43000031	4502.65	NH_2 A-X (0,7,0)-(0,0,0) 303-211
4503.37	9.34000015	4503.09	Unid
4506.76	10.31000042	4507.03	Unid
4509.46	8.60000038	4509.68	Unid
4510.82	10.46000004	4510.84	NH_2 A-X (0,7,0)-(0,0,0) 101-111
4513.52	6.59999990	4513.52	Unid
4515.55	7.63999987	4515.59	C_2 Swan 1-0 R1(87) R2(86) R3(85)
4518.26	10.35000038	4518.14	Unid
4519.61	9.44999981	4519.69	C_2 Swan 1-0 R1(86) R2(85) R3(84)
4520.97	11.46000004	4521.42	NH_2 A-X (0,7,0)-(0,0,0) 101-211
4522.99	8.47999954	4523.18	C_2 Swan 1-0 R1(85) R2(84) R3(83)
4524.35	6.23999977	4524.35	Unid
4525.70	7.25000000	4525.55	NH_2 A-X (0,6,0)-(0,0,0) 625-515
4527.05	7.67999983	4527.24	C_2 Swan 1-0 R1(84) R2(83) R3(82)
4528.41	7.71999979	4528.25	NH_2 A-X (0,7,0)-(0,0,0) 202-312
4529.76	7.36999989	4529.86	Unid
4531.11	6.36999989	4530.63	C_2 Swan 1-0 R1(83) R2(82) R3(81)
4533.82	9.57999992	4533.57	C_2 Swan 2-1 R1(79) R2(78) R3(77)
4535.85	8.36999989	4535.32	NH_2 A-X (0,6,0)-(0,0,0) 423-313 bl
4535.85	8.36999989	4535.32	NH_2 A-X (0,7,0)-(0,0,0) 303-413 bl
4537.87	11.27000046	4537.88	NH_2 A-X (0,6,0)-(0,0,0) 523-413
4541.26	7.88000011	4540.82	NH_2 A-X (0,6,0)-(0,0,0) 321-211
4543.96	7.15000010	4543.87	C_2 Swan 2-1 R1(76) R2(75) R3(74)
4545.99	8.57999992	4545.86	C_2 Swan 3-2 R1(73) R2(72) R3(71)
4548.69	8.36999989	4548.81	C_2 Swan 3-2 R1(72) R2(71) R3(70)
4551.40	10.39999962	4551.72	C_2 Swan 3-2 R1(71) R2(70) R3(69)
4552.75	9.14999962	4552.62	C_2 Swan 1-0 R1(77) R2(76) R3(75)
4554.78	6.71999979	4554.88	NH_2 A-X (0, 6,0)-(0,0,0) 221-211
4556.13	7.78000021	4556.51	C_2 Swan 1-0 R1(76) R2(75) R3(74)
4557.48	12.30000019	4557.56	C_2 Swan 3-2 R1(69) R2(68) R3(67)
4560.19	11.60000038	4560.42	C_2 Swan 3-2 R1(68) R2(67) R3(66)
4562.89	10.61999989	4563.33	C_2 Swan 3-2 R1(67) R2(66) R3(65)
4564.24	11.84000015	4564.41	Unid
4566.94	14.56000042	4566.92	C_2 Swan 1-0 R3(71)
4570.32	7.36999989	4570.60	C_2 Swan 1-0 R1(72) R2(71)
4571.68	11.27000046	4571.79	C_2 Swan 3-2 R1(64) R2(63) R3(62)
4573.70	9.59000015	4573.79	C_2 Swan 1-0 R1(71) R2(70)

4575.05	10.27999973	4574.60	C_2 Swan 3-2 R1(63) R2(62) R3(61)
4576.41	10.48999977	4576.00	C_2 Swan 2-1 R3(64)
4579.11	10.64000034	4578.96	C_2 Swan 2-1 R3(63)
4581.81	8.14999962	4582.05	C_2 Swan 2-1 R1(64) R2(63)
4583.16	8.94999981	4582.80	C_2 Swan 3-2 R1(60) R2(59) R3(58)
4584.51	9.32999992	4584.35	C_2 Swan 1-0 R3(66)
4588.57	9.23999977	4588.52	NH_2 A-X (0,6,0)-(0,0,0) 221-331
4591.27	9.30000019	4591.04	C_2 Swan 1-0 R3(64)
4592.62	8.72000027	4592.61	NH_2 A-X (0,6,0)-(0,0,0) 321-431
4593.97	11.15999985	4593.98	C_2 Swan 1-0 R1(65) R2(64)
4595.99	11.36999989	4596.03	C_2 Swan 3-2 R1(55) R2(54)
4597.35	11.47999954	4597.53	C_2 Swan 1-0 R1(64) R2(63)
4599.37	9.64000034	4599.85	C_2 Swan 2-1 R1(58) R2(57)
4602.07	10.05000019	4602.59	C_2 Swan 2-1 R1(57) R2(56)
4604.10	7.57999992	4604.01	C_2 Swan 1-0 R3(60)
4605.45	8.53999996	4605.58	C_2 Swan 2-1 P1(93)R1(56)P2(92)R2(55)P3(91)
4606.80	9.43999958	4606.81	C_2 Swan 1-0 R1(61) R2(60)
4608.82	12.10000038	4608.83	C_2 Swan 3-2 R3(48)
4612.20	11.19999981	4612.24	Unid

symmetry region, u — expansion velocity, g — acceleration of molecules in the gravity field of the Sun, φ — an angle between the z axis and g-vector, $r_{0k} = 2u^2/g$ — characteristic size of a coma, $K_0(y)$ - Mack Donald's function.

The physical parameters of neutral gaseous molecules C_2 (5165Å), C_3 (4050Å), CN (4200Å) velocity of expansion, lifetime, the legth pathes of parent and daughter molecules are given in the Table 4,5.

From Table 5 we see that real velocities of expansion of the C_2, C_3 and CN molecules in the coma of comet C/2000 WM1 diverse noticeably from velocity of expansion for gas, determined by Delsemme's formula $V = 0.58/\sqrt{r}$ which gives the values of expansion velocities.

Table 3. BVRI magnitudes of comets 9P/Tempel 1 and C/2004 Q2 (Machholz)

Comet	Date	B	V	R	I
9P/Tempel 1	03/15/05	16.5	15.8	15.5	15.3
C/2004 Q2	03/14/05	12.1	12	11.9	–

Table 4. Physical parameters of neutral gaseous cometary components of C_2, C_3 and CN (Shulman's model)

Species	Velocity, m/sec	Life time, 10^6 s	Comet	Date
C_2 (5165Å)	222	1.36	9P/Tempel 1	14/03/2005
C_3 (4050Å)	102	0.38	9P/Tempel 1	14/03/2005
CN (4200Å)	67	1.35	9P/Tempel 1	14/03/2005
CN (4200Å)	>300	>50	Machholz C/2004 Q2	18/12/2004
C_3 (4050Å)	363	5.13	Machholz C/2004 Q2	18/12/2004
C_2 (5165Å)	535	39.9	Machholz C/2004 Q2	18/12/2004
C_2 (5165Å)	855	73.4	Machholz C/2004 Q2	15/03/2005
C_2 (5165Å)	88	609	17P/Holmes	02/11/2007
C_2 (5165Å)	209	25.6	37P/Forbes	04/07/2005

Table 5. Physical parameters of neutral gaseous cometary components of C_2, C_3 and CN (Hasers's model). Note: L_{par} (clc) – the calculated path length of a parent molecule, L_{dau} (clc) — the calculated path length of a daughter molecule

Species	L_{par} (clc)	Ldau (clc)	Comet	Date
C_2 (5165Å)	$1.24 \cdot 10^3$	$1.21 \cdot 10^4$	9P/Tempel 1	14/03/2005
C_3 (4050Å)	–	–	9P/Tempel 1	14/03/2005
CN (4200Å)	–	–	9P/Tempel 1	14/03/2005
CN (4200Å)	$1.12 \cdot 10^5$	$2.10 \cdot 10^5$	Machholz C/2004 Q2	18/12/2004
C_3 (4050Å)	$2.78 \cdot 10^3$	$6.15 \cdot 10^5$	Machholz C/2004 Q2	18/12/2004
C_2 (5165Å)	$2.13 \cdot 10^4$	$1.60 \cdot 10^5$	Machholz C/2004 Q2	18/12/2004
C_2 (5165Å)	$2.64 \cdot 10^4$	$8.60 \cdot 10^5$	Machholz C/2004 Q2	15/03/2005
C_2 (5165Å)	$2.3 \cdot 10^3$	$3.08 \cdot 10^5$	37P/Forbes	04/07/2005

7. SEARCH OF LUMINESCENCE CONTINUUM IN SPECTRA OF COMETS 9P/TEMPEL 1, C/2004 Q2 (MACHHOLZ), 37P/FORBES AND 17P/HOLMES

The comet 9P/Tempel 1 — the main target of the Deep Impact mission was observed with SCORPIO 1 installed in the Prime Focus of the 6-m telescope of the SAO of the RAS on March 16–17, 2005 (Mount Pastukhov, Nizhny Arkhyz, Northern Caucase, Russia). The observations were obtained 2.5 months before collision of the copper impactor of the Deep Impact spacecraft with the 6-m nucleus of short periodic comet 9P/Tempel 1. During the same nights we observed also spectra of new comet C/2004 Q2 (Machholz).

We suppose that in spectra of comets 9P/Tempel 1 and Machholz (C/2004 Q2) we detected the real luminescent cometary continuum tied with the luminescence of the comet organic species which are in comet dust particles (CHON-particles).

8. SEARCH AND DETECTION OF COMETARY LUMINESCENCE CONTINUUM IN SPECTRA OF COMETS C/2004 Q2 (MACHHOLZ), 9P/TEMPEL 1 AND 37P/FORBES

For the first time a luminescence continuum was detected in the comet Halley (1P) spectrum by G.Nazarchuk, who found out two broad features with the maximum of intensity near 395 and 510 nm [1, 2]. They were part of the scattered solar continuum. In this paper is investigated spectra of comets 9P/Tempel 1 and Machholz (C/2004 Q2), with the aim to determine the real level of the non-solar-origin

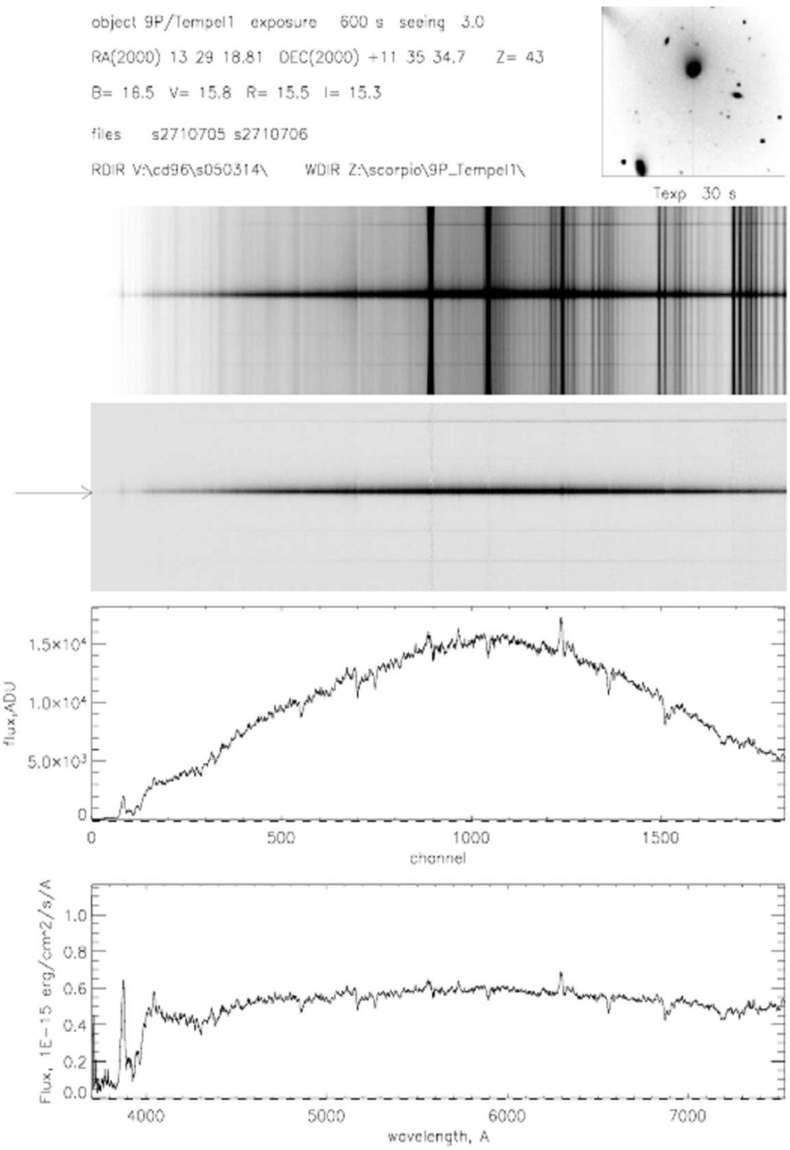

Fig. 1. The monochromatic image, the two slit spectra and distribution of energy in the spectrum of comet 9P/Tempel 1 on March 14, 2005

continuum in the spectral region 350–600 nm. Spectra of these comets were observed with the help of the 6-m BTA telescope and the spectrograph SCORPIO with the long slit at the Special Astrophysical Observatory of the Russian Academy of Sciences. In the high spatial and spectral resolution spectra of several comets has been noticed, that the equivalent width of the basic Fraunhopher lines is less than in the solar spectrum (Fig. 1–2).

Such phenomenon is connected with presence of an additional component of a continuous spectrum in cometary radiation. As a source of this additional radiation the luminescence organic cometary motes can serve. That fact testifies that spatial distribution of this source finds out very strong concentration to a cometary nucleus.

Unfortunately, the luminescent luminescence in this case has a wide spectrum without significant features that complicates identification of a radiating material. Thus, a cometary spectrum Icom consists

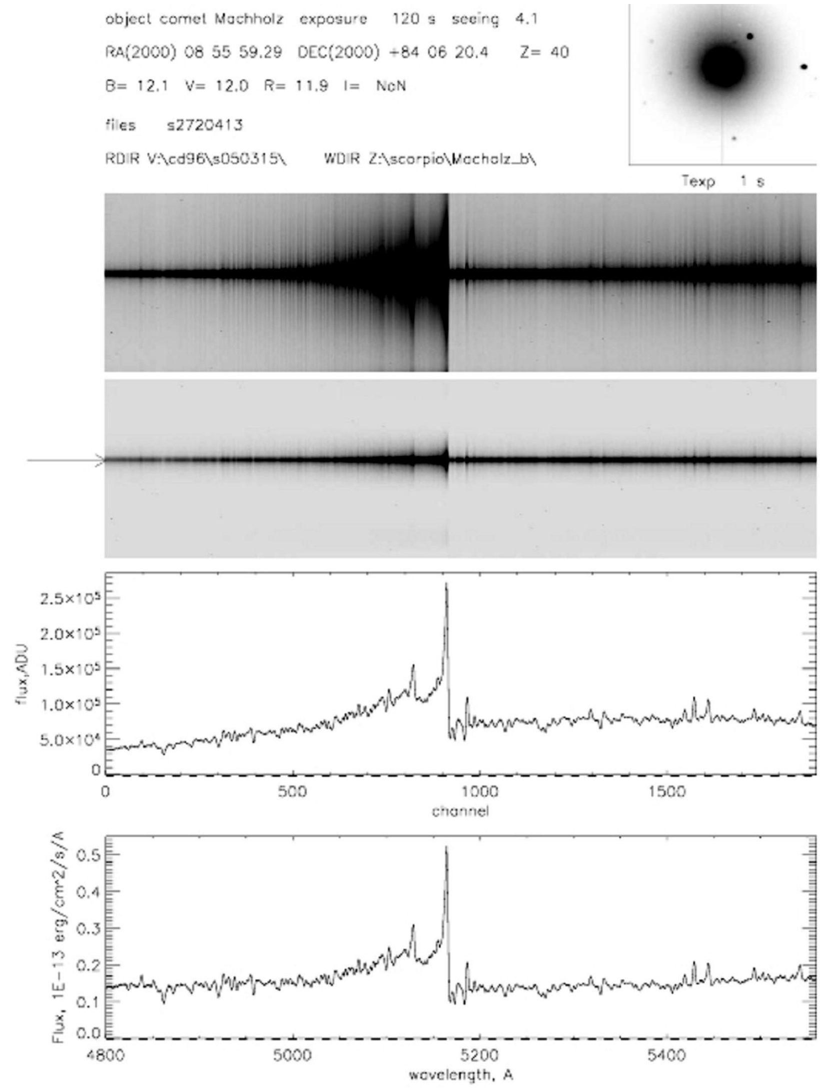

Fig. 2. The monochromatic image, the two slit spectra and distribution of energy in the spectrum of comet C/2004 Q2 (Machholz) on March 15, 2005

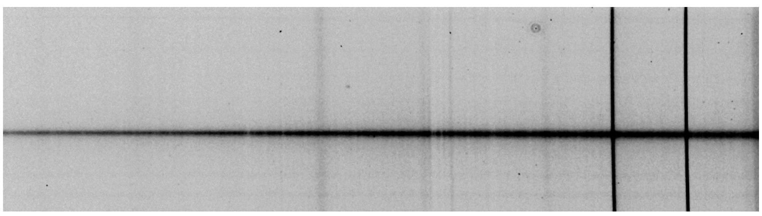

Fig. 3. The slit spectrum of comet 37P (Forbes) on July 4, 2005

of three components:

$$I_{\text{com}}(\lambda) = I_e(\lambda) + I_s(\lambda) + I_l(\lambda),$$

where I_e — an emission cometary spectrum, I_s — the solar spectrum reflected by cometary dust, I_l — a cometary luminescent continuum.

Spectral regions with no strong emission lines are selected for determination of a level of a luminescent continuum $I_l = 0$. On these regions of a spectrum is accepted, that the level of a luminescent continuum does not vary. Thus, for the selected regions of a cometary spectrum it is possible to accept

$$I_{\text{com}}(\lambda) = k \times I_f(\lambda) + l,$$

where $I_{\text{com}}(\lambda)$ — the known solar spectrum which is calculated taking into account the spectral resolution of a cometary spectrum and its discontinuity, k — factor which characterizes reflective ability of cometary dust, l — intensity of a luminescent continuum. In practice parameters k and l are selected so that to receive the best accordance to a region of cometary continuum (fig. 8).

Uniting data on a level of a luminescent continuum for different spectral regions, gives possibility to study behaviour of a luminescent continuum in all cometary spectrum.

The given technique was used for studying a luminescent continuum in spectra of comets C/2004 Q2 Machholz and 9P/Tempel 1 (fig. 9–11).

The maximum of a luminescent continuum of comet C/2004 Q2 Machholz is close to 630 nanometers.

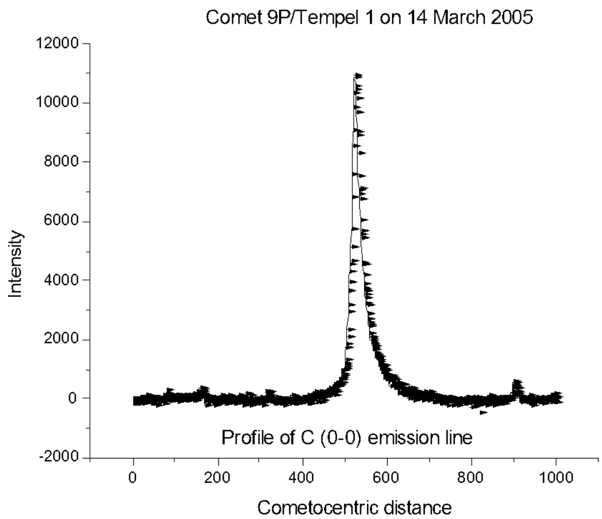

Fig. 4. Profile of brightness in the emission line C_2(0-0) in the spectrum of comet 9P (Tempel 1) on 14 March 2005

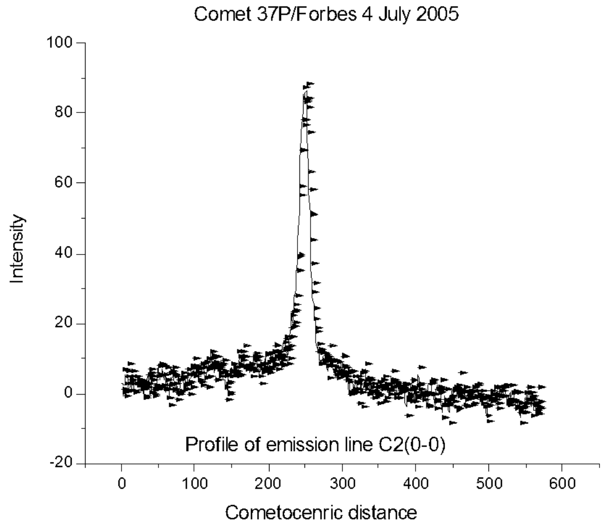

Fig. 5. Profile of brightness in the emission line C_2(0-0) in the spectrum of comet 37P (Forbes) on 4 July 2005

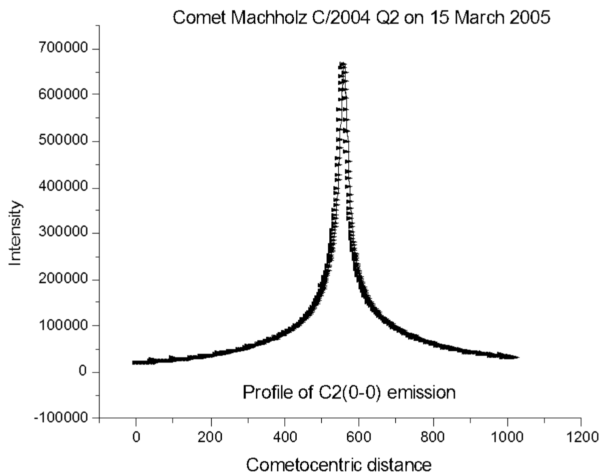

Fig. 6. Profile of brightness in the emission line C_2(0-0) in the spectrum of comet C/2004 Q2 (Machholz) on 15 Mar. 2005

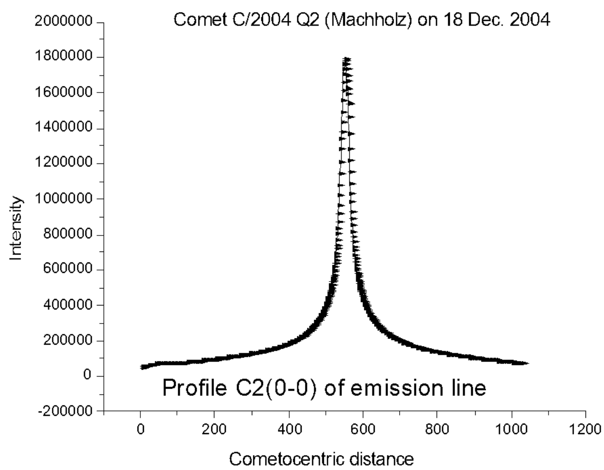

Fig. 7. Profile of brightness in the emission line C_2(0-0) in the spectrum of comet C/2004 Q2 (Machholz) on 18 Dec. 2005

In this region its intensity reaches 46

For comet 9P/Tempel 1 the level of the luminescent cometary continuum is 30% of the level of the total cometary continuum with the maximum near wave length 525 nm.

For comet 37P/Forbes as the preliminary analysis had shown the level of the luminescent cometary continuum is 20% of the level of the total cometary continuum with the maximum near wave length 450 nm.

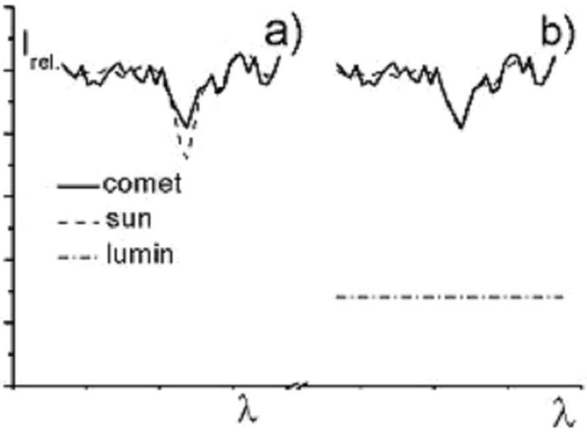

Fig. 8. Detection of a luminescent continuum in a cometary spectrum: a) standard method of determination of a level of the reflected solar spectrum, b) a level of a solar continuum taking into account a luminescent continuum of cometary dust radiation.

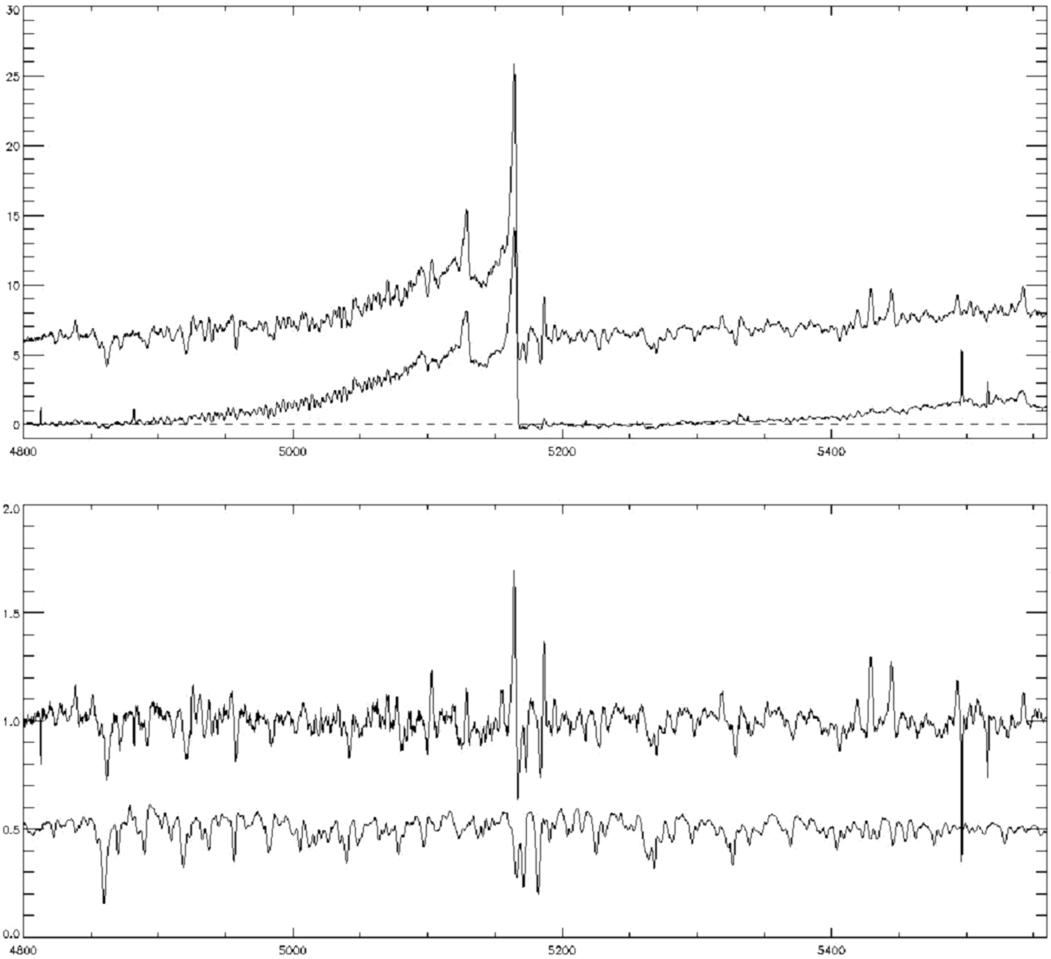

Fig. 9. Detection of the cometary luminescent continuum in the spectrum of comet C/2004 Q2 (Machholz) observed on 15 March 2005

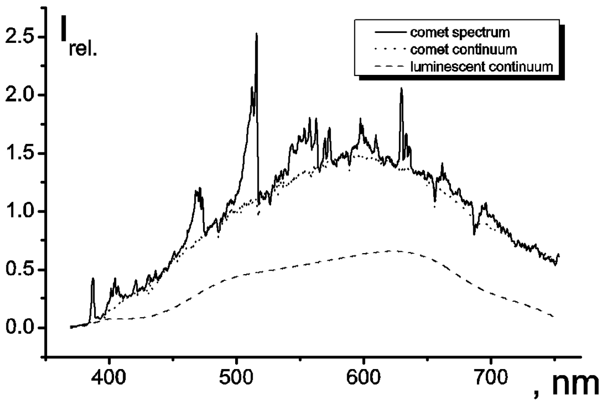

Fig. 10. A spectrum of comet C/2004 Q2 Machholz with dedicated cometary continuum and a luminescence of cometary dust level of total cometary continuum. Maximum of intensity of the cometary luminescent continuum is close to 630 nm [4, 5, 7]. In this spectral region the intensity of cometary luminescent continuum equal to 30% from the total cometary continuum (42% from the intensity of the Fraunhopher spectrum).

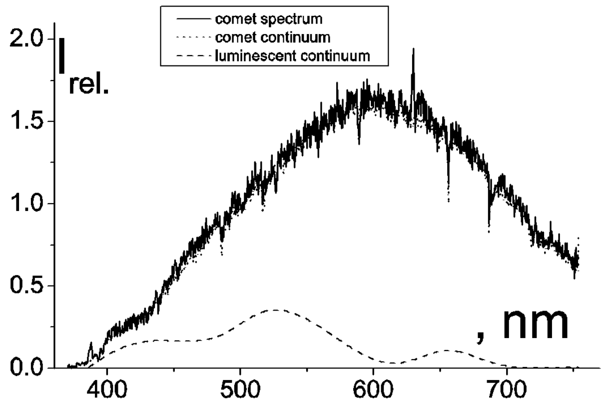

Fig. 11. A spectrum of comet 9P/Tempel 1 with dedicated cometary continuum and a luminescence of cometary dust level of total cometary continuum

As it was shown by Nazarchuk an Chorny [13] there are following some alternative sources of cometary luminescence continuum in optical region: 1) continuous spectrum of C_2H radical which arises under photolisis of the C_2H_2 molecules; 2) The sputtering of water ice particles at temperature below 100 K by electrons with the energy between 20 and 300 eV; 3) photoluminescence of lonsdeleite crystals which are the white grains of diamond and can be included in composition of graphitev particles; 4) Ordinary scattering by silicates as well as their Roentgen luminescence.

Photoluminescence of the polycyclic aromatic hydrocarbons (PAHs). The analysis shows that the possible contribution 2, 3 and 4 sources is sufficiently slight. Source 1 can contributes to the continuum with the maximum at 510 nm. For details 630, 525 and 450 nm, photoluminescence of small PAHs (anthracene C14H10, pyrene C16H10, chrysene $C_{18}H_{10}$, tetracene $C_{18}H_{12}$, and some other PAHs is the most possible.

9. CONCLUSION

On the basis of these observations energy distributions in the spectrum for comets 9P/Tempel 1, C2004 Q1 (Machholz) on March 14–15, 2005 and in the spectrum for comet 37P/Forbes on July 4, 2005 were constructed .

The detailed identification of emission lines in spectra of comet 37P/Forbes was made.

With the help of Shulman's and Haser's models on the basis of analysis of profiles of brightness in selected emission lines along the spectrograph slit some physical parameters of selected molecules of the neutral cometary atmosphere (velocities of the outflow of particles, times of life and length path of parent and daughter molecules for CN, C_2 and C_3 were determined. BVRI photometry of comet Tempel 1 and Machholz had shown that comet 9P has color as the Sun, but comet Machholz was bluer very much thaan the Sun.

We suppose that in spectra of comets 9P/Tempel 1, C/2004 Q2 (Machholz) and 37P/Forbes we detected the real luminescent cometary continuum tied with the luminescence of the comet organic species which are in comet dust particles. For comet 9P/Tempel 1 the level of the luminescent cometary continuum is 30% of the level of the total cometary continuum with the maximum near 525 nm and for comet C/2004 Q2 (Machholz) the level of the luminescent cometary continuum is 46% of the level of total cometary continuum with the maximum near 630 nm.

For comet 37P/Forbes as the preliminary analysis had shown the level of the luminescent cometary continuum is 20% of the level of the total cometary continuum with the maximum near wave length 450 nm. Comparison of spectra of three comets shows that new comet C/2002 Q2 in Oorts sense has the more high level of luminescent continuum and therefore more number of organic particles. It is main results of the present investigations.

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