DISCOVERY OF HIGH–SPEED SODIUM CLOUDS IN JOVIAN MAGNETOSPHERE AS A RESULT OF ITS INTERACTION WITH THE COMET SHOEMAKER–LEVY 9 MATTER

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The spectral monitoring of Jupiter was performed at the Crimean Astrophysical Observatory during July–August 1994. More than 210 spectra were received on July 20, when the Comet SL 9 Q fragments were falling onto Jupiter and the weather condition was favourable. Their analysis allowed to discover a new phenomenon when comet matter interacted with Jovian magnetosphere. We observed sodium D-line emission splashes of different intensity before explosion of the Q fragments in the planet atmosphere.

OBSERVATIONS

The spectral observations were performed at the 0.5-m meniscus telescope with a diffractional spectrograph having the inlet circular 6 arcsec diaphragm and a digital recording TV complex. The spectrograph covered 5700–7400 Å with a resolution 20 Å. The exposition time was of 26 sec [1]. We had a possibility to inspect the diaphragm location on the planet disk continuously. We registered the spectra from the spots along the $-45°$ latitude, disk centre, east and west limbs of equator, and the places near the northern pole.

The spectra of July 20 were compared with those on July 19, when the Na D-line was observed only as an absorption line and its average equivalent width was of 1.3 Å, *i.e.*, practically equal to that value of solar D-line. On July 20, when the Q fragments were falling, the spectral observations lasted 4 hours (17–21^h UT). The emission with variable intensity in the spectral range 5850-5940 Å is present in all the spectra.

The 5890–5896 Å emission could belong only to the Na D-line because no other species could produce this emission under the considered circumstances. It had an unusual time behaviour and Doppler shift. Its typical view was the sequence of the fast flashes. This Na emission had the following characteristics:

1. The mean equivalent width was equal to 2.5 Å with maximum value up to 5 Å.
2. The emission was recorded at different places of the planet disc. The dimension of luminous region was estimated as 140,000 km or more.
3. The most powerful Na flashes were observed during 1.1 hour, when the distance of the Q fragment from the Jovian centre was about $3R_j$. The typical characteristic time of the flashes was near 1 minute. The intensity of flashes steeply decreased at 0.5 hour before the mean impact moment of the Q fragments.
4. The sodium emission had a Doppler shifts up to 30 Å corresponding to the velocity 1500 km/s. We note that the brighter blue shift component was presented during all the time, but the red shift component was partly blended by a water absorption band.
5. During the moments when intensive sodium emissions were observed, the lithium 6807 Å emissions were also recorded. The Doppler shift was near to that of Na. Correct measurement of lithium emissions was very uncertain because of the presence of blends of another species in this place of a spectrum.

The brightest flashes were observed, when the Q2 and Q1 fragments passed the region of magnetosphere at a distant $3R_j$ from the planet centre. Thus, the appearance and behaviour of this sodium emission was connected with the Q fragments, which were disintegrated into at least 7–8 parts and were surrounded by extended coma with splinters and dust particles of different sizes [2].

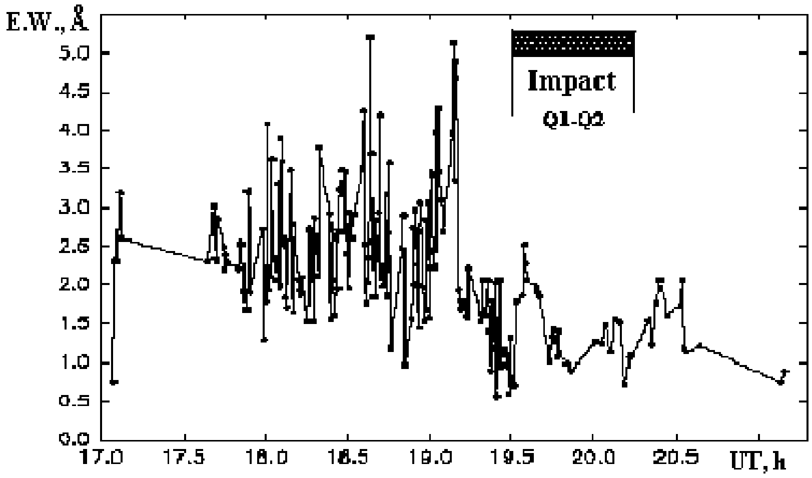

Figure 1: Equivalent width (E. W., Å) of the sodium emission D-line blue shift component versus time UT, 1994 July 20. The moments of the Q1–Q2 impacts are shown with black band

DISCUSSION

The sodium and its compounds exist in comet matter. The Na escaped from dust and surfaces of numerous splinters owing to sputtering, when they were crossing the magnetosphere. The intense flux of magnetospheric fast electrons, protons and ions existed just in the region about $3R_j$. These particles bombarded dust and surfaces of splinters. Due to the sputtering sodium was released first of all and nearly 10% of the atoms were ionized. The electrons, atoms and ions which emerged in this process were drawn into subsequent ionization process according to the mechanism of the critical ionization velocity. Increasing density of energetic electrons intensified the sodium ionization. The developing of local electric fields in plasma caused acceleration of Na ions. The processes of sputtering, ionization of Na atoms, accelerations of ions and recombination were developing simultaneously.

Plasma became unstable and this caused occurrence of lower-hybrid oscillations and noncollisional transfer of energy. Ions and electrons were involved in further processes. The geometry of the Q fragments passing through the inner magnetosphere was such that the Io's electric current tube could promote acceleration of Na ions in the longitudinal electric fields up to 1500 km/s. Recombination of sodium ions occurred due to charge exchange process. Thus, clouds of high-speed sodium atoms were produced and developed in the process of the interaction of comet dust with inner Jovian magnetosphere.

REFERENCES

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