OPTICAL SPECTROSCOPY OF THE B AND C FRAGMENTS OF COMET 73P/SCHWASSMANN-WACHMANN 3 AT THE ESO VLT*. E. Jehin[1], J. Manfroid[1], H. Kawakita[2], D. Hutsemékers[1], M. Weiler[3], C. Arpigny[1], A. Cochran[4], O. Hainaut[5], H. Rauer[6], R. Schulz[7], J.-M. Zucconi[8], [1]Institut d'Astrophysique et de Géophysique, B-4000, Liège, Belgium, (e-mail: ejehin@ulg.ac.be), [2]Department of Physics, Kyoto Sangyo University, Kyoto 603-8555, Japan, [3]LESIA, Observatoire de Paris, F-92195, Meudon, France, [4]Department of Astronomy and McDonald Observatory, University of Texas at Austin, C-1400, Austin, USA, [5]ESO, Alonso de Cordova 3107, Casilla 19001, Santiago, Chile, [6]Institute of Planetary Research, DLR, 12489 Berlin, Germany, [7]ESA/RSSD, ESTEC, NL-2200 AG Noordwijk, The Netherlands, [8]Observatoire de Besançon, F-25010, Besançon, France.

Introduction: Comet 73P/Schwassmann-Wachmann 3 (SW3) had split into 3 major components in 1994, then again into 2 more fragments in 1996. When the comet returned to perihelion in 2001, only 3 fragments were recovered, and no new ones appeared. At its return to perihelion in 2006, SW3 started again to split and about 60 fragments were reported.

The bulk of our knowledge of comets chemical composition comes from the study of their outgassing products (dust and gas constituting the coma and the tail) coming from the surface layers of the comet, while very little information is available from the interior. A splitting comet is the ultimate Deep Impact experiment, exposing the deep interior of the comet giving us a chance to compare the surface material with volatiles from the unaltered nucleus interior.

Observations: We report high resolution (R=80.000) and high signal-to-noise optical spectra obtained with UVES at the ESO VLT on the two main fragments 73P-C and 73P-B on May 27 and June 12 UT 2006, respectively. The comet was at 0.95 and 0.94 AU from the Sun and very close to the Earth at 0.15 and 0.25 AU, respectively. While the leading component 73P-C was stable during that period, the -B fragment underwent many outbursts and splitting events [2]. Long slit low resolution FORS2 spectra covering the 330-620 nm wavelength range were also obtained on component -B on May 28 and June 22 and on component -C on July 01 UT.

Isotopic ratios : The $^{12}C/^{13}C$ and $^{14}N/^{15}N$ isotopic ratios were derived from the CN inner coma measured in the $B^2\Sigma^+$-$X^2\Sigma^+$ (0,0) emission band around 387 nm following the method described in [1,2,3]. We found values of $^{12}C/^{13}C$=100±20 and $^{14}N/^{15}N$=220±40 for fragment -C and of 100±30 and 210±50 for –B [4]. The isotopic composition of both fragments are indistinguishable, even though -B was in outburst probably releasing a larger amount of fresh material than -C. The most surprising result is the $^{14}N/^{15}N$ ratio (215±30 averaged over B and C) which appears significantly different from the values around 140 we measured for a majority of comets of different origins and dynamical classes (Oort Could, Jupiter and Halley Family comets) [3]. It is clearly different from the value in 88P/Howell (140±15) another Jupiter Family Comet [5]. Even the material released by Deep Impact on comet 9P/tempel 1 [6], and during the exceptional outburst of comet 17P/Holmes [7] gave, within the error bars, $^{14}N/^{15}N$ ratios around 140. The value $^{14}N/^{15}N$ measured in SW3 is then intermediate between the telluric value (272) [8] and the bulk of comets, showing a smaller enrichment in ^{15}N [3]. The $^{12}C/^{13}C$ ratio is, on the other hand, the same as in all other comets and in agreement with the solar and terrestrial values of 89 [8]. All this points to a peculiar composition for SW3, rather than a difference between pristine versus surface material.

Ortho-to-para ratios (OPR): We also observed the NH_2 (0,9,0) band at 610 nm, which was used to derive the OPR of NH_2 on the basis of a fluorescence excitation model [9]. OPRs of 3.03±0.05 and 3.02±0.05 were derived for 73P-C and 73P-B, showing that both fragments are again very similar [4]. These values are consistent with the high-temperature limit (OPR=3.0), allowing us to derive lower limits of T_spin for ammonia of ~40K. A high value of T_spin (compared to other comets) was also found for SW3 in the case of H_2O [10]. If T_spin is linked to the conditions of formation of the molecule i.e linked to the temperature in the solar nebula where the comet formed [9], we could infer that SW3 was born in a warmer place than other Oort Could and JF Comets that show T_spin ~30K. It is worth noting that such high temperature might also explain the unusual nitrogen ratio of SW3 with respect to other comets as fractionation mechanisms are very sensitive to temperature and predict a smaller enrichment in ^{15}N at higher temperatures [11].

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