

POSITIVE ION COMPOSITION MEASUREMENTS IN THE STRATOSPHERE - EXPERIMENTAL ASPECTS AND RESULTS.

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RECENTLY IT HAS BEEN DISCOVERED THAT UPPER ATMOSPHERIC ION COMPOSITION IS MAINLY CONTROLLED BY MINORITY GASES, AND THAT ION COMPOSITION DATA MAY BE RELEVANT IN DETERMINING TRACE GASES. THE SCIENTIFIC OBJECTIVE OF THE BALLOON-BORNE ION MASS SPECTROMETER ION CONSTRUCTED AT THE BELGIAN INSTITUTE FOR SPACE AERONOMY, IS TO DETERMINE THE POSITIVE ION COMPOSITION OF THE STRATOSPHERE AT ALTITUDES BETWEEN 30 AND 40 KM.

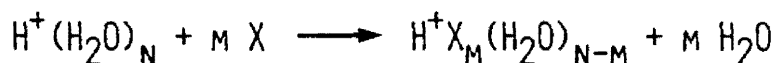
EXPERIMENTAL ASPECTS

THE PRESENT ION MASS SPECTROMETER IS A 2ND GENERATION PAYLOAD EVOLVING FROM A SIMPLER ONE, AFTER A SERIES OF PRELIMINARY BALLOON FLIGHTS DURING 1974 AND 1975. BASICALLY, THE ACTUAL PAYLOAD CONSISTS OF A QUADRUPOLE MASS FILTER COMBINED WITH A HIGH SPEED LIQUID HELIUM CRYOPUMP (1), AND THE APPROPRIATE ELECTRONICS. AMBIENT POSITIVE IONS ARE SAMPLED THROUGH A SMALL HOLE WITH A DIAMETER BETWEEN 0.01 AND 0.03 CM. BEFORE LAUNCHING, THIS APERTURE IS COVERED BY A POLYIMIDE PLUNGER, REMOVABLE BY A SPRING LOADED ALUMINIUM ARM AND A PYROTECHNICAL CABLE CUTTER. THE OPENING DEVICE IS ACTIVATED BY TELECOMMAND AFTER THE GONDOLA HAS REACHED THE CHOSEN FLOATING ALTITUDE (1). THEN, POSITIVE IONS AND NEUTRAL GAS CAN ENTER THE MASS SPECTROMETER. NEUTRAL GAS IS PUMPED BY THE HIGH SPEED LIQUID HELIUM CRYOPUMP, RESULTING IN A VACUUM OF APPROXIMATELY 10^{-5} TORR, IN THE MASS SPECTROMETER REGION. THE FLANGE WITH ION SAMPLING HOLE IS ELECTRICALLY INSULATED FROM THE GONDOLA. THEREFORE A NEGATIVE "DRAW-IN" POTENTIAL ON THIS FLANGE WILL ATTRACT POSITIVE IONS AND WILL OVERCOME POSSIBLE CHARGING UP OF THE PAYLOAD. POSITIVE IONS FOCUSED BY AN ELECTROSTATIC LENS INTO THE QUADRUPOLE MASS FILTER, ARE FILTERED THERE ACCORDING TO MASS-TO-CHARGE RATIO. AFTER PASSING THE MASS FILTER, THEY REACH A SPIRALTRON ELECTRON MULTIPLIER, GIVING RISE TO CHARGE PULSES COUNTED BY AN APPROPRIATE ELECTRONIC UNIT. PULSE COUNTING TECHNIQUES ARE ABSOLUTELY NECESSARY IN VIEW OF LOW STRATOSPHERIC ION DENSITIES ENCOUNTERED (10^2 TO 10^4 cm^{-3}). ION COUNTER CONTENTS ARE TRANSMITTED BY TELEMETRY AS PULSE CODE MODULATED SIGNALS. THE ELECTRONIC UNITS OF THE ACTUAL PAYLOAD CONSIST OF A SET OF BATTERIES, A POWER REGULATOR OF THE BOOSTER TYPE, A QUADRUPOLE POWER SUPPLY, HIGH VOLTAGE UNITS FOR ELECTRON MULTIPLIER AND VACUUM GAUGE, A PULSE COUNTER, A MASS CONTROLLER AND AUXILIARY INSTRUMENTS MEASURING PRESSURE AND TEMPERATURE IN THE GONDOLA AND THE LIQUID HELIUM LEVEL IN THE CRYOPUMP. ALL ELECTRONIC UNITS ARE HOUSED IN A HERMETICALLY SEALED CONTAINER, PRESSURISED WITH DRY AIR AT

1 ATM, AVOIDING SPARKING IN HIGH VOLTAGE COMPONENTS. THE MASS RANGE OF THE QUADRUPOLE IS FROM 0 TO 109 AMU, ITS RESOLUTION IS VARIABLE AND CAN BE CHANGED BY TELECOMMAND. TELECOMMAND POSSIBILITIES ARE EXTENDED BY A PROGRAMMABLE CONTROL UNIT (2), ALLOWING THE CHOICE OF 16 MEASURING TASKS WITH 16 TELECOMMAND CHANNELS ONLY. SWITCHING THE EXPERIMENT ON AND OFF IS PERFORMED BY TELECOMMAND ALSO. DATA ARE PROCESSED ON LINE BY A MINI-COMPUTER, THEREBY FACILITATING SELECTION OF RESOLUTION AND MASS DOMAIN SCANNED BY THE QUADRUPOLE, ACCORDING TO SIGNAL STRENGTH.

DISCUSSION AND IMPLICATIONS ON THE POSITIVE ION-MOLECULE CHEMISTRY OF OF THE STRATOSPHERE

THE SCIENTIFIC RESULTS OBTAINED DURING THE SEPTEMBER 1977 CAMPAIGN OF THE CENTRE NATIONAL D'ETUDES SPATIALES IN AIRE-SUR-L'ADOUR (FRANCE), WERE PUBLISHED IN NATURE (271, 642, 1977) (3). THE REACTION SCHEME GIVING RISE TO PROTON HYDRATES (PH) WAS KNOWN ALREADY (4). THE EXPECTED PROTON HYDRATES HAVE BEEN OBSERVED, HOWEVER NON-PROTON HYDRATES (NPH) WERE ALSO OBSERVED. ALL OBSERVED NPH MASSES FIT THE FORMULA $H^+X_M(H_2O)_N$ (SEE TABLE), SUGGESTING THAT A NEW STEP HAS TO BE ADDED TO THE REACTION SCHEME, NAMELY :



X SHOULD BE A MOLECULE WITH A PROTON AFFINITY (P.A.) LARGER THAN THAT OF H_2O AND SHOULD HAVE A MASS OF 41 ± 2 AMU. IN VIEW OF THIS, SEVERAL POSSIBLE X MOLECULES HAVE BEEN SUGGESTED, HOWEVER NaOH SEEMS TO BE THE MOST LIKELY ONE SO FAR (5). ALL PROPOSED MOLECULES REMAIN SPECULATIVE AS LONG AS HIGHER RESOLUTION ION MASS SPECTRA COMBINED WITH NEUTRAL COMPOSITION MEASUREMENTS ARE NOT AVAILABLE.

THESE INVESTIGATIONS ARE NOW PREPARED AT THE BELGIAN INSTITUTE FOR SPACE AERONOMY.

REFERENCE

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