様　式　Ｃ－１９、Ｆ－１９－１、Ｚ－１９　（共通）

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研究課題名（和文）星間分子の気相反応における「核スピン選択則」解明への挑戦

研究課題名（英文）Experimental study on nuclear-spin selection rules in gas-phase chemistry

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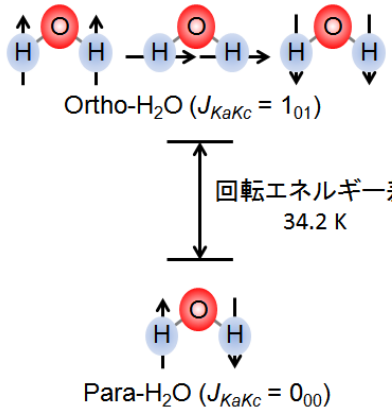
研究成果の概要（和文）：H2O, NH3などの星間分子の核スピン異性体比（オルソ／パラ比）は，核スピン統計重率比よりも低いことが知られているが，その原因については未だにほとんどわかっていない．考えられる仮説として「宇宙にはパラH2が豊富に存在するため，パラH2の気相化学反応によって別の分子（H2Oなど)が生成したときに，パラH2の核スピンが保存され生成分子にもパラ状態のものが多く生成する」可能性，つまり気相化学反応における核スピン選択則によるものが考えられる．そこで本研究ではこの仮説を検証するために，パラH2の気相化学反応で生成した分子の核スピン異性体比を直接測定するための実験装置の設計・開発をおこなった．

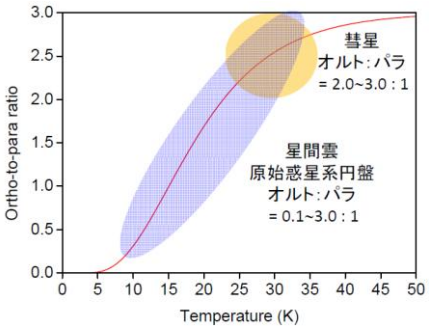
研究成果の学術的意義や社会的意義
天文学や地球惑星科学では「星間分子（H2O, NH3, CH4など）の核スピン異性体比から，分子が過去にどのような環境で生成したのかがわかる」と考えられており，積極的に観測研究が進められてきた．しかし，近年の代表者の実験研究によって「H2Oの核スピン異性体比からはH2O氷の生成時の環境を知ることができない」ことが明らかになったため，星間分子の核スピン異性体比が本当は何を意味しているのかは，30年以上の観測研究の蓄積にも関わらず未だに不明である．本研究によって「星間分子の核スピン異性体比が異常な値をもつのは，気相化学反応が原因である」という新説を提案・検証するための基礎が確立した．

研究成果の概要（英文）：Observations of interstellar space and cometary comae have reported the existence of gaseous molecules (e.g., H2O) with anomalous ortho-to-para ratios (OPRs) less than the statistical value (three for H2O). However, the true meaning of the observed OPRs in cometary comae and star- and planet-forming regions is still unknown. Gas-phase chemical reactions involving para-H2 should be key to account for the anomalously low ortho-to-para ratios (OPRs) exhibited by interstellar and cometary molecules, because the abundance ratio of nuclear spin isomers of the product molecules (e.g., H2O) can be para-enriched owing to the nuclear-spin selection rules. In this work, a new experimetal apparatus is designed and constructed for the understanding of the nuclear-spin selection rules of gas-phase chemical reactions involving para-H2.

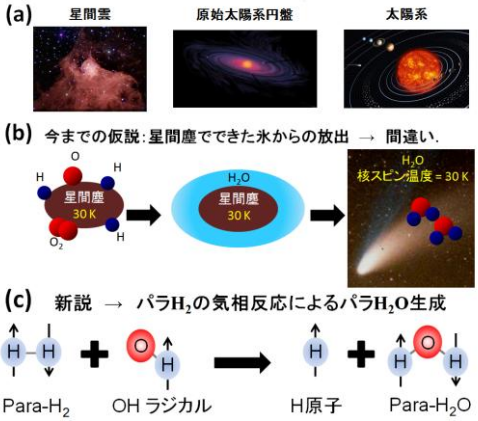
研究分野：地球惑星科学およびその関連分野

キーワード：核スピン選択則　気相化学反応　核スピン異性体　星間化学　彗星　星間分子雲　原始惑星系円盤

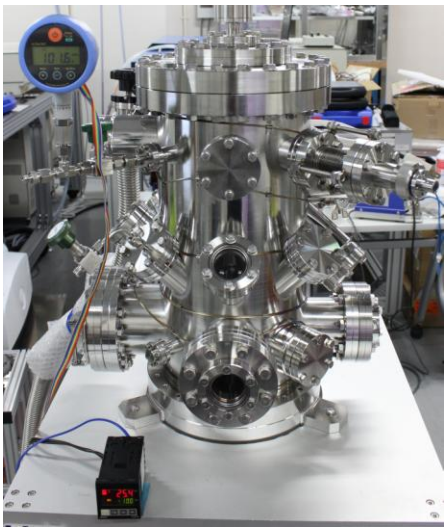




□ 1: □ □ H_2O c□ □2 bb□)O (↑↑, ↑↓□)□ H_2O(□ 5"□)□ □ H_2O(M□)□ M□ ¡b□ H_2O □ H_2O bc3□ 3 : 1 ¡□ □ □ H_2Ob□ □b¡□ □ □ N (0□K¡□



□ 2: (a) □b□ b"4□ (b) □b b 05¡□ b□0□M □ H_2O 4d□ □ □M □ 0.1 µm b(□ K□b□ □ (c) K□□ □ H_2b□ □ □ H_2O ¡□



□ 3: 20K/0b□

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