

Development of the Physics of Spin Isomers

Selected papers on the physics of gaseous spin isomers. The choice is subjective.

- 1895 Runge and Paschen. Spectra of He and “parhelium”. [ApJ, 3, 4 (1896)].
- 1912 Eucken. Anomalous specific heat for H₂ (Sitzber. Preuss. Akad. Wiss. 41).
- 1922 Gerlach and Stern. Space quantization (ZPhys 9, 349)
- 1922 A. Fowler. Use of ortho-helium and parhelium as recommendation by Bohr.
- 1924 Pauli. Introduction of nuclear spin for hyperfine structure (NW 12, 742).
Mecke. Discovery of intensity alternation in N₂⁺ spectrum (ZPhy 28, 261).
- 1925 Pauli. *ad hoc* exclusion principle (ZPhy 31, 765).
Uhlenbeck and Goudsmit. Introduction of electron spin (NW 13, 953).
- 1926 Heisenberg (ZPhy 38, 41). Dirac (Proc. R. Soc. A112, 661). Deeper formulation of Pauli’s Exclusion Principle. Heisenberg explains ortho and para helium.
- 1927 Heisenberg. Ortho-H₂ (*J* odd) and para-H₂ (*J* even) (ZPhy 41, 239).
Hori. Observation of 3:1 intensity alterations in H₂ spectrum (ZPhy 44, 834).
Dennison. Stable o-, p-H₂ to explain the specific heat (Proc. R. Soc. A115, 483).
- 1929 Bonhoeffer and Harteck. Preparation of pure para-H₂ (ZPhy Chem. B4, 113).
- 1933 Wigner. Theory for the stability of ortho and para H₂ (ZPC B23, 28).
Mecke. Observation of intensity alternation in H₂O (ZPhy 81, 313).
- 1940 Pauli. Theoretical proof of Pauli’s exclusion principle (PhRv 58, 716).
- 1964 Raich and Good. Ortho→para H₂ spontaneous emission *J* = 1→0. (ApJ 1389, 1004).
- 1967 Curl et al. Theory for spin conversion in polyatomic molecules (JChPh 46, 3220).
- 1968 Oka. Experimental proof for stability of o- and p-NH₃ (JChPh 49, 3135).
- 1970 Ozier et al. Observation of o-p transition of CH₄ in magnetic field (PhRvL 24, 642).
- 1973 Dalgarno et al. Ortho-para conversion of H₂ by reaction with H⁺ (ApL 14, 77).
- 1977 Quack. Symmetry selection rules for reactive collisions (MolPh 34, 477).
- 1980 Borde et al. Observation of ortho-para transition of free SF₆. (PhRvL 24, 642).
- 1984 Krasnoperov et al. Spin isomer selection by light-induced drift (JETPL 39, 143).
- 1985 Chapovsky et al. First study of conversion rate in polyatomics, CH₃F (CP 97, 449).
- 1989 Kern et al. Separation of spin isomers of H₂CO by UV photolysis (CPL 154, 292).
- 1986-1990 Chapovsky. Huge isotope dependence in CH₃F and ¹³CH₃F (JETP 70, 895)
- 1991 Le Bourlot. Ortho-para conversion of H₂ by reaction with H₃⁺ (A&A 242, 235).
- 1997 Uy et al. Experimental nuclear spin selection rules in reaction (PhRvL 78, 3844).
- 2000 Chapovsky et al. Separation of spin isomers of ¹³C¹²CH₄ (CPL 322, 424).
- 2004 Oka. Chemical selection rules by angular momentum algebra (JMoSp 228, 635).
Tanaka et al. Observation of interactions between o- and p-C₂H₃ (JChPh 120, 3604).
- 2005 Sun et al. Measurement of spin conversion for ethylene C₂H₄ (Sci 310, 1938).
- 2011 Crabtree et al. Studies of o-p ratio of H₃⁺ in hydrogen plasmas (JChPh 134, 194310).
- 2013 Tanaka et al. Ortho-para H₂O⁺ spontaneous emission (JPCA 117, 9584).
- 2014 Takagi et al. High spin conversion rate in CH₃OH (private communication).

References: S. Tomonaga, *The Story of Spin*, University of Chicago Press 1997
T. Oka, Orders of Magnitude and Symmetry in Molecular Spectroscopy, *Handbook of High Resolution Spectroscopy*, John Wiley & Sons Ltd, Vol I, pp 633-658.