MO 21 Heteronuclear Cold Molecules

Zeit: Samstag 08:30–10:00 Raum: HU 2091

MO 21.1 Sa 08:30 HU 2091

Deceleration and trapping of OH radicals — •Nicolas Vanhaecke[1], SebastiaanY.T. van de Meerakker[2,1], and Gerard Meijer[2,1] — [1]Fritz-Haber-Institut der Max-Planck-Gesellschaft, Faradayweg 4-6, 14195 Berlin, Germany — [2]FOM-Institute for Plasmaphysics 'Rijnhuizen', Edisonbaan 14, 3439 MN Nieuwegein, the Netherlands

Over the last years our group has been developing methods to get improved control over the absolute velocity and over the velocity spread of molecules in a molecular beam. These methods rely on the, quantum state specific, force that polar molecules experience in inhomogeneous electric fields. This force is rather weak, but nevertheless suffices to achieve complete control over the molecular motion, and polar molecules in a supersonic beam can be brought to rest and confined in an electrostatic trap.

Here, we report on the deceleration and electrostatic trapping of ground state OH radicals. The experiments are performed in a new generation molecular beam deceleration machine, designed such that a large fraction of the molecular beam pulse can be slowed down and trapped. Depending on details of the trap loading sequence, typically 10^5 OH ($X^2\Pi_{3/2}, J = 3/2$) radicals are trapped at a density of 10^7 cm^{-3} and at a temperature in the 50-500 mK range. In our deceleration experiments, state-selective molecular beams with a computer-controlled velocity distribution are produced, offering the unique possibility to perform collision and reactive scattering experiments as a function of the continuously tunable collision energy and with unprecedented energy resolution.

MO 21.2 Sa 08:45 HU 2091

An Electrostatic Storage Ring for Neutral Molecules — •Cynthia E. Heiner[1], David Carty[1], Hendrick L. Bethlem[1,2], Floris M. H. Crompvoets[2], and Gerard Meijer[1] — [1]Fritz-Haber-Institut, Berlin, Germany — [2]FOM-Institute for Plasma Physics Rijnhuizen, Nieuwegein, The Netherlands

We present here the experimental results of a hexapole torus storage ring for neutral, dipolar molecules. In these experiments, a package of deuterated ammonia molecules in a single rovibrational state is decelerated using time-varying inhomogeneous electric fields. These molecules, with a temperature of ca. 300 μK in the moving frame, are loaded into the ring. The interaction of the molecules with the electric fields inside the ring provides the required centripetal force to retain the molecules, with a tangential velocity of 92 ms^{-1}, in a circular orbit. The package of molecules can be observed for more than 50 distinct round trips, corresponding to 40 m of travel and almost 0.5 s storage time.

This ring traps the molecules only tangentially, having no means of keeping the package together along the direction of flight. Therefore, after some time the molecules spread out and fill the entire ring. To correct this, we have designed and constructed a new sectional storage ring that allows for a bunching scheme to be implemented. We will discuss the electric field configurations needed to re-bunch the package. Additionally, simulations which demonstrate that we meet the stability requirements for such an apparatus will be shown.

MO 21.3 Sa 09:00 HU 2091

Preparation of Ultracold Molecular Hydrogen Ions in a Linear RF-Trap — •Bernhard Roth, Peter Blythe, Ulf Fröhlich, Helmut Wenz, and Stephan Schiller — Heinrich-Heine-Universität Düsseldorf

We present an experiment aimed at high-resolution spectroscopy of the ro-vibrational level structure of HD^+. As one of the simplest molecules, HD^+ is particularly suitable to test theories of molecular structure. Furthermore, the spectroscopic values of the ro-vibrational transition frequencies of HD^+ can be used to obtain a more accurate value of the fundamental constant m_e/m_p.
The HD^+ molecular ions are confined in a linear Paul trap and cooled via Coulomb interaction by laser cooled $^9Be^+$ ions stored simultaneously in the same trap (sympathetic cooling). For strong cooling a phase transition to an ordered state (Coulomb crystal) occurs. Stable crystals containing several 100 localized hydrogen molecules and up to 6.000 $^9Be^+$ ions at translational temperatures <20 mK were obtained. We have studied the properties of such mixed-species ion plasmas and found good agreement with results from molecular dynamics simulations. Currently, we are setting up a stabilized laser system for high–resolution spectroscopy of the (ν = 0, N = 4) - (ν = 4,N = 4) transition of HD^+ at 1.4 μm.

MO 21.4 Sa 09:15 HU 2091

Fokussierung eines SO_2 Strahls — •Ch. Lisdat, S. Jung und E. Tiemann — Institut für Quantenoptik, Universität Hannover, Welfengarten 1, 30167 Hannover

Die Kraft, die polare Moleküle in inhomogenen elektrischen Feldern erfahren, kann zur Abbremsung und Speicherung [1,2] oder zur Manipulation ihrer Trajektorien [3] genutzt werden. Wir diskutieren quantitativ die Fokussierung eines langsamen SO_2 Strahls durch eine elektrostatische Hexapollinse. Durch den Stark-Effekt werden im Hexapol bestimmte Quantenzustände selektiert und für diese Überhöhungen der Teilchenzahl von mehr als einer Größenordnung beobachtet.

Diese Untersuchungen lassen Aussagen über die Realisierbarkeit eines Stark-Abbremsers für das schwere SO_2 Molekül mit seinem nichtlinearen Stark-Effekt zu. Kaltes SO_2 kann durch Photodissoziation in die ebenfalls kalten Fragmente SO und O zerlegt werden, wobei die Überschußenergie und Besetzung der inneren Zustände durch die Wahl des Photodissoziationsschrittes bestimmt werden können. Analog zu Feshbach-Resonanzen in Atomstößen sollte das Schwellverhalten über externe Felder beeinflußbar sein.

[1] H.L. Bethlem, G. Meijer: Int. Rev. Phys. Chem. **22**, 73 (2003)
[2] E.R. Hudson *et. al.*: Eur. Phys. J. D, online published (2004)
[3] T. Junglen *et. al.*: Eur. Phys. J. D, online published (2004)

MO 21.5 Sa 09:30 HU 2091

An AC electric trap for molecules in high-field seeking states — •Jacqueline van Veldhoven[1,2], Hendrick L. Bethlem[2], and Gerard Meijer[1] — [1]Fritz-Haber-Institut der Max-Planck-Gesellschaft, Berlin, Germany — [2]FOM-Institute for Plasma Physics "Rijnhuizen", Nieuwegein, The Netherlands

During the last years, trapping of high-field seeking molecules using optical fields has been experimentally demonstrated. However, typical trap depths and trapping volumes are small ($\approx$ 1 mK and $\approx 10^{-5}$ cm^3). It is important to develop deeper and larger volume traps for molecules in high-field seeking states, for instance because the absolute ground-state of any molecule is high-field seeking. When molecules are trapped in their absolute ground-state, increasing their phase-space density via evaporative cooling will be possible, as trap loss due to inelastic collisions can be avoided. Moreover, when heavier molecules with small rotational constants are to be trapped, a trap for molecules in high-field seeking states is the only viable option. Trapping of molecules in high-field seeking states in an electric field can be achieved in a cylindrically symmetric field that is designed such that it is focusing in the radial direction and defocusing in the axial direction, or vice versa. By switching between these two different electric field configurations, a molecule that is either in a high- or in a low-field seeking state will experience a force that is alternatingly focusing and defocusing in each direction, with an overall focusing effect. We report here on the trapping of ammonia molecules in both high-field seeking and low-field seeking states in such a novel AC electric trap.

MO 21.6 Sa 09:45 HU 2091

Stark-Abbremsung von CO im hochfeldsuchenden Zustand — •Kirstin Wohlfart[1], Jochen Küpper[1], Hendrick L. Bethlem[2], Stephan A. Schulz[1], Henrik Haak[1] und Gerard Meijer[1] — [1]Fritz-Haber-Institut der Max-Planck-Gesellschaft, Faradayweg 4-6, D-14195 Berlin — [2]FOM Instituut voor Plasmafysica "Rijnhuizen", Edisonbaan 14, NL-3439 MN Nieuwegein

Innerhalb der letzten Jahre wurden in unserer Arbeitsgruppe Methoden entwickelt, um neutrale, polare Moleküle mit Hilfe zeitlich variierender hoher elektrischer Felder abzubremsen und zu kühlen [1]. Zur Abbremsung von Molekülen in hochfeldsuchen Zuständen muss transversal die *Alternate Gradient* Fokusierung angewandt werden. Deren Anwendbarkeit zur Fokusierung neutraler, polarer Moleküle wurde von unserer Gruppe gezeigt [2]. Um auch größere Moleküle, bei denen alle Zustände praktisch hochfeldsuchend sind, möglichst bis zum Stillstand abbremsen zu können, haben wir ein neues Experiment aufgebaut. Zur Charakterisierung und Optimierung des neuen Aufbaus dienen Messungen zur

Stark-Abbremsung und Fokussierung von metastabilen CO ($a^3\Pi_1$) im hochfeldsuchenden Zustand. Hier präsentieren wir die neuen Messungen zur Fokusierung und Abbremsung von CO und diskutieren weitergehende Experimente zur Abbremsung größerer Moleküle.

[1] H.L. Bethlem und G. Meijer, *Int. Rev. Phys. Chem.* **22**, 73–128 (2003)
[2] H.L. Bethlem, A.J.A. van Roij, R.T. Jongma und G. Meijer, *Phys. Rev. Lett.* **88**, 133003 (2002)