People Involved

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Ultra-dense Hydrogen

2.3 ± 0.1 pm!

Leif Holmlid in his lab at Gothenburg University

240 Surface Science Publications since 1973
Rydberg atom (n,l,m)
Radiative lifetime goes as $n^5$
Rydberg atom condensation into Rydberg matter

Dimer state is unstable

0.2 eV bonding per state possible if \( d \approx 2.9a \)

Theory of the condensed state in a system of excited atoms

Rydberg matter types
Rydberg matter a frozen plasma state?

Conditions for forming Rydberg matter: condensation of Rydberg states in the gas phase versus at surfaces Leif Holmlid 2002 *Journal of Physics: Condensed Matter, Volume 14, Number 49*
Surface catalytic process of formation of Rydberg matter

- Styrene catalyst $\text{Fe}_2\text{O}_3$:K or similar
- Desorbed H in 1s state
- Adsorbed H
- Rydberg state
  - lowest energy state
  - formation
- Desorbed Rydberg H atom in high quantum number state
  - lifetime in ms
  - for example $l = 7$, $m = \pm 6$
1. Low Kinetic energy (630 eV/u) release results

Bond length experiments with Time of Flight mass spectroscopy
Time of flight analysis

Possible cluster breakups are many.

For example cluster of mass 16 can break up \((2 < > 1) \ 4 < > 12 \ ...\)

and so on for other total masses.
1. Low Kinetic energy (630 eV/u) release results

FIG. 5. (Color online) The laser beam position in the cloud below the emitter is shown for the data in Fig. 4. The approximate regions in space for different forms of condensed deuterium are indicated.
There should be no peaks here!

2.3 pm bond distance!

H₂ molecule 72 pm bond distance!
Leif Holmlid  High Kinetic energy (MeV/u) release results
Fast kinetic energy release flight signal

- Outer collector 163 cm
  - $\tau_1 = 7 \text{ ns}$
  - $\tau_2 = 13 \text{ ns}$
  - delay 14 ns

- Inner collector 64 cm
  - $\tau_1 = 4 \text{ ns}$
  - $\tau_2 = 20 \text{ ns}$
  - delay 10 ns

- Zero bias 163 cm
  - 13 ns
  - 39 ns
  - 26 ns

Signal (mV)

Signal (V)

Time (ns)
LH high kinetic energy release interpretation

Leif assumes high mass therefore particles with MeV energy are observed, not electrons: 50 KeV energy

\[ H(0) \text{ (protons, deuterons)} \text{ are transformed! into} \]

\[ \mu^\pm \text{ Muons} \rightarrow e^\pm \text{ electrons} \]
\[ K^\pm \text{ kaons} \rightarrow \pi^\pm \text{ pions.} \rightarrow \mu^\pm \text{ muons} \rightarrow e^\pm \text{ electrons} \]

Observed decay time similar to:
K-mesons: 13 ns
\( \pi^- \)-mesons: 26 ns
Muons: 2,2 us
Leif Holmlid  spontaneous Particle emission

Annihilation of $p^+$?

Following experimental evidence for high energy particle observation have been published by Leif:

1. Beta electron distributions even after meter distances in air
2. The detection via metal converters
3. Life-time of muons measured
4. The pion and kaon lifetimes measured
5. The current of charged particles detected in air and in vacuum by ferrite coils, with pion lifetimes
6. Expected deflection of muons in magnetic fields

These evidences are still very indirect and therefore weak. The aim with the cooperation is to take the next step and either confirm these results and find better means of performing these experiments in real high energy physics lab or to find alternative explanation for the observed results.
Experimental techniques for studying Rydberg matter of Hydrogen
Sveinn Ólafsson University of Iceland
2019 LANR/CF Colloquium at MIT
LANR Science and Engineering: From Hydrogen to Clean Energy Production Systems

TOF detectors

MRD500 ultra fast diode

TOF: Coil

TOF: Faraday cup
Sindre Norway 2018
LH high kinetic energy release observed

- TOF length: 236 cm
- TOF: 31 ns
- Lifetime in the range of lifetime of pions $\pi$
- If we assume pion $\pi$ the energy is 7.55 MeV.
- "Muon" detector shows elevated spectra
Experimental lab in Iceland
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University of Iceland

Thin film growth and characterisation

Rydberg matter exp.

Lithography and clean room

Conductivity cell
Experimental development
last 6 months
Experimental techniques for studying Rydberg matter of Hydrogen

Sveinn Ólafsson University of Iceland

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Diode Trigger
Camera
Lens
Motor x,y,z
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4GHz scope, 20GS/s  50ps
High Kinetic energy release Iceland January 15, 2019

- TOF : 4.0 ± 0.7 ns
- TOF length: 105 cm
- Speed 0.95c!
- Decay time: ≈26ns
- If we assume π-mesons, the energy is 90 MeV
- ”Muon” detector shows elevated spectra

Observed decay time similar to:
K-mesons: 13 ns
π-mesons : 26 ns
Muons : 2,2 us
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Surface Barrier detector
Theoretical possibilities for proton annihilation

(It is speculation time)

- 3N-proton -> 3N-anti-lepton.
- Allowed according to the Standard Model!
- Never been observed, big bang high temperature conditions $>10$ TeV
- Too high energy for the LHC accelerator at CERN.

- Candidate to solve mystery in cosmology i.e. Baryogenisis.
- Baryonic asymmetry, i.e. the imbalance of matter and antimatter
- Driven by the Adler–Bell–Jackiw anomaly in electroweak interactions

- Why appearing in LH experiments?
- Quantum Bose Einstein condensation/entanglement in the Ultra-dense phase of protons due to long interaction times (days instead of $10^{-25}$ sec.)?
Emission from reactor LH “Muon” signal in Norway

Counts: 3 532 102 Time: 500 s

Without $D_2$ gas

With $D_2$ gas

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LH “Muon” signal in Iceland

January 8 2019

January 10 2019
In lab out of lab comparison

- **Red**: far away from lab -1600V G4
- **Blue**: far away from lab -1700 G1
- **Yellow**: Reactor -1600V G4
- **Purple**: Reactor -1700V G1
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Cloud chamber tracks
Thank you for listening
Tunneling fusion rate model for the Coulomb potential

Rate = Gamov probability of crossing the barrier $\times$ attempt frequency

Reaction cross sections are not included. Calculation are shown for $f = 10^{16}/s$.

$P_g(E) \equiv e^{-\frac{E_g}{E}}^{1/2}$

2.3 $\pm$ 0.1 pm!
**Fusion**

Fusion plasma reactions at the core of the Sun

- $D + D \rightarrow n + ^3\text{He} + 3.3\ \text{MeV}$
- $D + D \rightarrow p + ^3\text{T} + 4.0\ \text{MeV}$
- $D + D \rightarrow \text{He} + \gamma + 24\ \text{MeV}$
- $p + p \rightarrow D + e^+ + \nu_e + 0.42\ \text{MeV}$
- $p + p + e^- \rightarrow D + \nu_e + 1.44\ \text{MeV}$
- $p + D \rightarrow ^3\text{He} + \gamma + 5.5\ \text{MeV}$
- $p + ^3\text{He} \rightarrow ^4\text{He} + e^+ + \gamma + \nu + 18.8\ \text{MeV}$

Radioactive!

*Experimental techniques for studying Rydberg matter of Hydrogen*
*Sveinn Ólafsson University of Iceland*
*2019 LANR/CF Colloquium at MIT*
*LANR Science and Engineering: From Hydrogen to Clean Energy Production Systems*
Molecular muonium fusion, $\mu$-catalysed fusion known since 1947

Couloumb barrier is thin, frequency of tunnelling is high

$$f = \frac{E_{\text{vib}}}{h} \approx 10^{16}/s.$$  

Reaction is “directional” or “lined up”
Fusion time is less than one nanosecond
muon lifetime is too short to reach beak even

Experimentally, 

$$P_g(E) \equiv e^{-\frac{E_g}{E}^{1/2}},$$

$$E_g \equiv 2m_r c^2 (\pi \alpha Z_a Z_b)^2$$

Reactions products are the same as in the Sun!
Rutherford radium “like” calorimetry experiment

Heat generation above break-even from laser-induced fusion in ultra-dense deuterium

Leif Holmlid   AIP Advances, Volume 5, Issue 8, Pages artikel nr 087129 2015