# Session 21bE

## Mixing 2D electrons and atomic hydrogen on the liquid helium surface **21bE1**

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Two-dimensional (2D) electrons on liquid He are mixed with atomic H to study a fundamental chemical reaction between the electron and H on the He surface. As the 2D electrons and atomic H are mixed together, the decrease in the electron number is observed, of which the rate increases with lowering tempearture inversely proportional to Arrhenius' equation. This is suggesting that the atomic H adsorbed on the liquid He surface captures an electron to form negative hydrogen, $H^-$, which then submerge into liquid He. Activation energy of the reaction rate is about -2 K, which is about twice the adsorption energy of atomic H to liquid $^4$He, implying that two H atoms participate in the capturing of one electron. The dissociative attachment of electron to a rovibrationally excited $H_2$ molecule, which is an early product of hydrogen reconbination process, can be a candidate for such a reaction mechanism.

## Superfluid $^3$He - From Cosmology to Particle detection **21bE2**

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At very rapid superfluid transition in $^3$He, follows after a reaction with single neutron, the creation of topological defects (vortices) has been demonstrated in accordance with the Kibble-Zurek scenario for the cosmological analogue. We discuss here the extension of the Kibble-Zurek scenario to the case when alternative symmetries may be broken and different states nucleated independently. We have calculated the nucleation probability of the various states of superfluid $^3$He during a superfluid transition. We have established the new theory of transition from supercooled A phase to the B phase, triggered by nuclear reaction. Our theory explains the Stanford experimental results much better than well known "Baked Alaska" scenario. The superfluid $^3$He at very low temperatures can be considered as an ultimated Dark Matter detecter. Recently we was able to detect the mu-meson scattering with energy of 20 keV

## 21bE3 Rotating refrigerators for mK temperatures

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A few rotating cryostats have been constructed which are capable of cooling down to 100 $\mu$K and to rotate up to $\sim 1$ rev/s. Rotation is supported with compressed air or magnetic fluid bearings. A $^3$He-$^4$He dilution refrigerator is used for precooling a series connected copper nuclear cooling stage. The precooler may run continuously using rotating seals in the pumping lines or in single-cycle mode with adsorption pumping. Smooth rotation and low damping are essential to achieve a low-noise rotation spectrum (of $\sim \pm 1$ mrad/s). Interference in measurements is minimized if the rotation is precession-free and the rotating parts are rigidly fixed. A future challenge remains to achieve one or two orders of magnitude higher rotation velocities. This calls for magnetically supported and driven rotation of only the sample with its holder. The main use of rotating sub-mK cryostats is for quantized vorticity in He superfluids.