SUMMARY OF THE MINI-WORKSHOP ON MUON-CATALYZED FUSION, LOS ALAMOS, NEW MEXICO, DECEMBER 16–17, 1985

A rendezvous of researchers active in the field of muon-catalyzed fusion took place recently at the Los Alamos Meson Physics Facility (LAMPF). The meeting was organized by Steven E. Jones [Brigham Young University (BYU)] with the support of the Advanced Energy Projects Division of the U.S. Department of Energy (DOE). The meeting was characterized by open discussions and a marked *esprit de corps* as two dozen researchers grappled with several puzzles uncovered by muon-catalyzed fusion research.

New data acquired at TRIUMF regarding muon-induced *p-d* and *d-d* fusion were presented by Konrad Aniol (California State University, Los Angeles). A surprising preliminary result is that the rate of formation of muonic *p-d* molecules decreases with increased temperature in the range 100 to 400 K. Steven Jones reviewed recent results of muon-catalyzed *d-t* fusion experiments performed at LAMPF. The number of fusions per muon is strongly affected by the temperature, density, and deuterium-tritium (D-T) ratio of the target fluid. Many results can be understood in the framework of a model positing a strong resonance in the formation of muonic *d-t* molecules. However, the marked decrease in muon losses ("alpha-sticking") with increasing target density continues to be one of the major puzzles of the field. James Cohen (LAMPF) provided a possible explanation based on the observation that the electron-ion recombination rate in D-T mixtures rises with increasing density (and tritium fraction).

The smallness of the apparent alpha-sticking probability at high target density was the subject of considerable discussion. This observation (along with the equally surprising density dependence) was reported 2 years ago based on the experiments at LAMPF, and other experiments have not contradicted the findings. Mike Danos (National Bureau of Standards), Berndt Mueller (University of Frankfurt), and Johann Rafelski (University of Cape Town) presented an explanation based on the existence of a narrow resonance in the *d-t* fusion channel, whose presence can influence the final state energy of the muon and thus the alpha-sticking probability. Gerry Hale provided data regarding this nuclear resonance, from his experiments at Los Alamos. Hiroshi Takahashi (Brookhaven National Laboratory) gave results of calculations that support published conclusions of Rafelski and Mueller that the sticking probability can be reduced because a nuclear resonance in *d-t* fusion affects the wave functions in the d-t-μ molecular ion prior to fusion. Finally, Chi Yu Hu (California State University, Long Beach), on sabbatical leave at Lawrence Livermore National Laboratory, presented new calculations of the d-t-μ molecular binding energies and sticking in the $J=0$ and $J=1$ states. Sticking in the $J=0$ state agrees with earlier calculations, while sticking in the $J=1$ state is only 0.3% (before muon stripping). The latter value is consistent with current experiments, although the significance of this agreement was not established at the workshop.

Other workshop topics included resonant quenching of d-μ atoms in the $F=\frac{3}{2}$ hyperfine state [Mel Leon (LAMPF)], plans for calculating parameters of d-t-μ molecules [Krysztof Szalewicz (University of Florida)], a discussion of the interface between atomic and nuclear physics [Oliver Baker (Stanford University)], and an expression of encouragement from Ryszard Gajewski (director of the Advanced Energy Projects Division, DOE).

It is instructive to compare the 1985 workshop with an earlier one held at Jackson Hole, Wyoming, in June 1984. In 1984, discrepancies in measured values of the formation rate of d-d-μ molecules were discussed. By the 1985 meeting, the discrepancies were resolved in favor of the larger (Gatchina and LAMPF) values, but the TRIUMF data regarding the p-d-μ molecular formation rate raised new questions. In 1984, the dependence of the observed alpha-sticking fraction on D-T target density was announced; this continues as a major conundrum. The smallest sticking probability reported in June 1984 was ~0.6%. Progressing to higher D-T densities, the BYU/Idaho/Los Alamos group working at LAMPF reported a value of (0.35 ± 0.05)% at the 1985 gathering. Consistent with progress in theory and experiment, the average number of measured fusions per muon jumped from 80 in 1984 to 150 in 1985 with still larger yields anticipated. While no proceedings of the 1985 meeting is planned, a 350-page compilation of contributions to the Jackson Hole workshop is available from Prof. Steven Jones, Department of Physics and Astronomy, Brigham Young University, Provo, UT 84602. The sense of the working group assembled at Los Alamos in 1985 is that considerable progress may be expected by the time of upcoming muon-catalyzed fusion conferences (Madrid, June 1986; Tokyo, September 1986; Leningrad, May 1987).

Current observations appear favorable to long-term applications of muon-catalyzed fusion, but we must confirm, understand, and extend the results before definitive conclusions can be reached. In particular, we must learn how small the alpha-sticking fraction can become since this is clearly the primary bottleneck in the muon-catalyzed fusion process.

Steven E. Jones

Brigham Young University
Department of Physics and Astronomy
Provo, Utah 84602

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