Bubble Nucleation Efficiency for Dark Matter Detector

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Key Concept: Bubble Chamber

- A **bubble nucleation** occurs when the energy deposited is above energy threshold [2].
- Thus bubble chambers are **threshold detectors** so the bubble nucleation efficiency should be a step function [2].

Fig. 1.Data however, shows the bubble nucleation efficiency curve is not a step function.

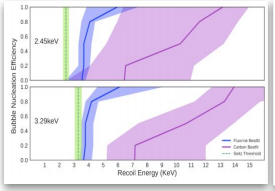
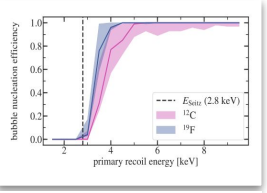
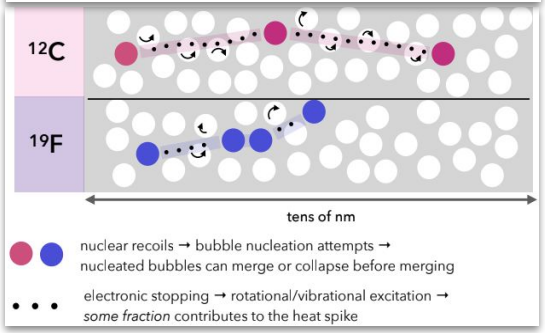


Fig. 2. Bubble nucleation efficiency for C3F8 modelled through simulations



The Model to be tested for Superheated Argon



Simulation Conditions and Results

- Liquid Argon superheated conditions: 130 K and 20 PSIA
- Lennard-Jones (LJ) parameters determined and calculate via Molecular Dynamics (MD) simulations [1].
- Bubble growth evolution obtained over time and from different directions. Similar results obtained for the simulation and the Seitz Model (theory) [2].

Fig.3. Argon bubble simulation results: Snapshots of the bubble growth in our simulation

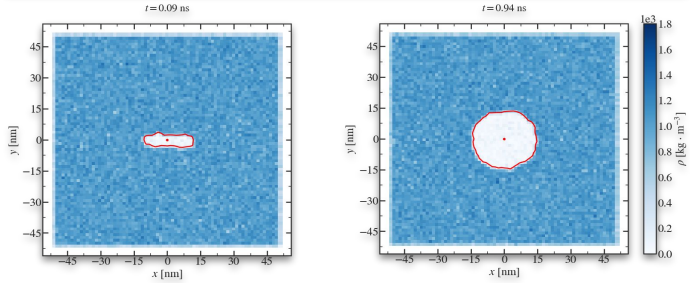


Fig. 4. Effective radius over time

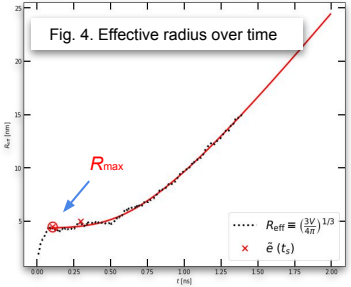
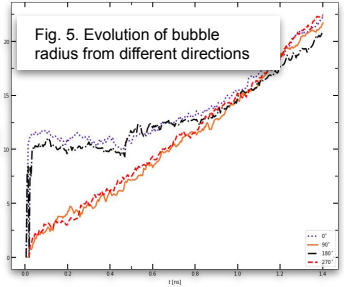


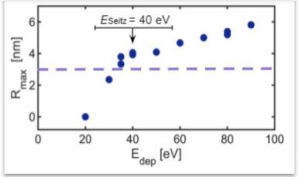
Fig. 5. Evolution of bubble radius from different directions



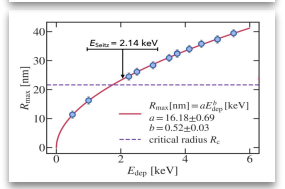
Conclusions and Future Work

- Simulated bubble evolution from **20 eV to 120 eV** energy deposited range in superheated liquid argon.
- Obtained the **Seitz Threshold Energy** for the superheated Liquid Argon following the same approach as for C_3F_8 [1].

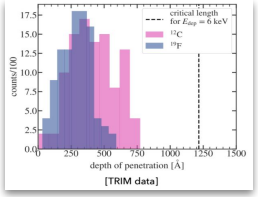
Results obtained with Argon.

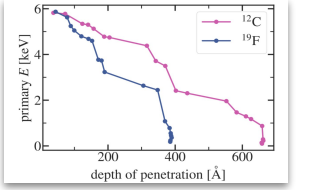


Results obtained with C_3F_8



- Next steps with SRiM: the Bubble nucleation efficiency





References:

1. Tetiana Kozynets, Scott Fallows, Carsten B. Krauss. Phys (2019), Modeling emission of acoustic energy during bubble expansion in PICO bubble chambers.

2.. Frederic Tardif, Direct detection of dark matter with the PICO Experiment and the PICO-0.1 calibration chamber.

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