

Development of Dry Dilution Refrigerator and Temperature Measurement with Quartz Tuning Fork

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We have developed “ dry ” dilution refrigerator with following purposes.

- (1) To make world record of the lowest temperature in “ dry ” dilution refrigerator
- (2) To establish a new type of thermometer with quartz tuning fork

As for (1), this is to apply “ dry ” dilution refrigerator as a precooling stage for adiabatic nuclear demagnetization stage. About (2), all of the current temperature measurement method in ultralow temperature is high-priced and complicated. As a solution to this problem, the temperature measurement with quartz tuning fork has been performed. ¹ Quartz tuning fork has settled in the condensate phase of mixing chamber, and resistance thermometer has mounted on external wall of mixing chamber. From fermi-liquid theory, amplitude of quartz tuning fork is proportional to the temperature of “ liquid ”. The quartz thermometer has been calibrated from 100mK to 15mK by a Ruthenium Oxide resistance thermometer which has been calibrated by 3He melting curve thermometer. As a result, we will report that we have made world record 4.5mK in “ dry ” dilution refrigerator, and quartz tuning fork allowed us to measure the temperature easily.

¹R. Blaauwgeers et al., J. Low Temp. Phys. **146**, 537 (2009).