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List of Author's Papers


5. H. Ohokubo, T. Furukawa and M. Murakami, *Development of Superconductive Hot-wire Anemometer for the Use Around 2K*, Advances in Cryogenic Engineering (To be published)
LIST OF AUTHOR'S PAPERS

List of Contributing Papers

1. T. Furukawa, M. Murakami and T. Iida, *Measurement of He II Evaporation Induced by Impingement of a Thermal Pulse on a He II-Vapor Interface*, Experiments in Fluids

2. T. Furukawa, M. Murakami and T. Iida, *Study of He II Evaporation in Continuum Region from He II-Vapor Interface Induced by a Thermal Pulse Impingement*, Journal of Low Temperature Physics