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Electrical Breakdown Characteristics in Fluctuating Fluids near Gas-liquid Critical Point of Helium[1] HITOSHI MUNEOKA, KEIICHIRO URABE, SVEN STAUSS, KAZUO TERASHIMA, The University of Tokyo — In order to unify discharge behavior in gases and liquids, we have experimentally investigated the breakdown voltages near the critical point of helium [critical temperature (T_c): 5.20 K, critical pressure (P_c): 0.227 MPa], for T = 5.02 - 5.50 K and P = 0.03 - 0.3 MPa, which includes the gaseous, liquid, and supercritical fluid (SCF) states of helium. Detailed measurements of micrometer-gap ($\sim$3 μm) direct-current discharges in the high density (0.1 – 27 mol/L) and ultra-pure (due to the very low temperature) medium allowed for the first time a clear observation of a critical anomaly of the breakdown voltage in helium. This anomaly - a local minimum of the breakdown voltage - could only be observed in micrometer gap discharges because the characteristic length of the local fluid structure has to be comparable to the gap distance. We also developed a discharge model that takes into account the local fluid structure in a fluctuating medium and the effect of small discharge volumes. The analysis and model suggest that the critical anomaly is caused by extended acceleration paths inside low density domains generated by the density fluctuation.

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