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Metal to Nonmetal Phase Separation in Expanded liquid Rubidium

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Quantum mechanical calculations of the ground state energy in pure electron gases reveal a mechanical instability, if they are sufficiently expanded. Appropriate scaling allows relating these gas densities to mass densities in real liquid alkali metals which are regarded as perfect model systems for free electron gases. It is found that the region of instability corresponds to 3-4 times the critical density which contradicts the common view of the density induced metal to non-metal transition in these systems located at about twice times the critical density. We have investigated the density dependence of the collective modes in liquid Rb to understand this discrepancy. Collective modes were chosen as suitable probes because their properties are highly sensitive to variations in the interatomic interactions, which are expected to occur if the electron gas ceases to exist. Experiments were carried out on the TOF instruments IN4 and BRISP, at the ILL in Grenoble. We find distinct $S(Q,\omega)$-variations when the density range is approached where the electron gas instability is predicted. Variation of mode- and $S(Q,\omega)$-maximum properties will be discussed. It is demonstrated that the observed behavior can be understood within a scenario recently suggested for the metal to non-metal transition in liquid Hg where localization of the conduction electrons forces the formation of a micro emulsion consisting of a dense metallic and less dense non-metallic phase. This scenario fully explains the observed $S(Q,\omega)$ density dependence along the explored density range and throws new light on the mechanism of the density-induced metal to non-metal transition in liquid metals.

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