Cooling liquids super-quickly: How to study supercooled water & co. at very, very low temperatures

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Supercooled liquids – liquids that are metastable with respect to the crystalline form – represent an important class of out-of-equilibrium systems whose study is related to a number of fundamental questions in statistical and condensed matter physics. Water represents one prominent example that highlights the relevance of supercooled liquids. Water's behavior is unusual with respect to that of most other liquids, and it was long speculated that clues about this anomalous behavior might be found at temperatures well below the melting point. However, the crucial question on how far liquid water may actually be cooled without instantaneously freezing to ice remained unanswered so far. But the importance of supercooled liquids is not limited to the study of water's properties alone. For instance, understanding the more general microscopic details of the crystallization process itself is crucial for diverse research fields such as atmospheric physics and material science. Such studies, however, were so far greatly hampered by the fact that the liquid-to-solid phase transition occurs on a very short time scale, especially at deep supercooling. Here I will show that the use of a microscopic laminar jet, formed by injecting a pressurized liquid through a micrometer-sized orifice into vacuum, offers a unique *Ansatz* to address the above experimental challenges. I will in particular discuss how the combination of liquid jets and state-of-the-art light scattering techniques allows the investigation of the properties and structural transformations in a class of supercooled liquids that are precluded to more conventional approaches.