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**Collision Universalities and the Quantum Pressure Standard**[1]

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Here we present recent work on two forms of universality in collision physics - universality refers to the existence of properties that are independent of short-range structural details. We discuss experimental observations of the universal and non-universal decay rate of ultra-cold, reactive molecules, and we report the discovery of a new form of universality for quantum diffractive collisions. We find that diffractive collisions, those that transfer the minimum energy allowed by quantum mechanics, are universal and that the energy transferred by them encodes information about the total collision cross section and the form of the interaction potential at long range. This universality phenomenon (which we refer to as QDU) is a manifestation of the Heisenberg uncertainty principle and a consequence of the collision induced particle localization. QDU occurs for any interaction and applies to collisions of both elementary and composite particles (e.g. nuclei, atoms and molecules). Using QDU for van der Waals interactions, we realize a self-defining cold atom sensor providing the first primary and quantum definition of pressure and particle flux for ultra-high vacuum applicable to any atomic or molecular species.

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