Source-Detector Framework for BEC Analogue Models of Gravity

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Two-level impurities in Bose-Einstein condensate (BEC) analogues of gravity act as localized source-detector probes for the emergent field theory in curved spacetime. Emphasizing source terms and Green functions, rather than field quantization, allows one to obtain a practical, measurement-oriented framework that (1) localizes and characterizes the quasinormal modes (QNMs) of the field, (2) visualizes QNMs excitation mechanisms, (3) quantifies their influence on spontaneous emission rates (Purcell effect), and (4) treats quantum processes on non-static backgrounds where a preferred vacuum state is ambiguous. I will present and explain the key methods of the framework, along with notable numerical results from my M.Sc. thesis (supervisor: Prof. Iacopo Carusotto, Trento BEC Center), and predictions for potential BEC experiments, with the aim of exploring how analogue gravity and impurity dynamics may offer insights into open quantum systems.