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# Gravitational Waves generation using the Lehmann-Symanzik-Zimmermann formalism

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Gravitational Waves (GW) emission is usually studied within the framework of the Regge-Wheeler-Zerilli equations, which are not exact and often times require numerical integration or extrapolation (a process which involves tuning additional parameters). Our aim is to prescribe a theoretical framework which alleviates some of these technical challenges by employing a Lehmann-Symanzik-Zimmerman (LSZ) like method, similar to how scattering is handled in Quantum Field Theory (QFT). This requires that the black hole is treated like an ensemble of gravitons bound by an effective potential, i.e. the black hole is a bound state of gravitons. Furthermore, the plunging star is treated like a localized scalar field which interacts with the black hole via an exchange of gravitons at any given moment. This incoherent beam of incoming gravitons then scatter off the black hole in this LSZ (scattering) picture. Our main objective is to find an analytical expression for the scattered beam of gravitons and explore additional effects stemming from the QFT framework employed.We prove that, in the limit of an infinite number of scattered gravitons, we recover the gravitational wave emitted by the binary system (plunging star & black hole) via an emission of graviton coherent states.
Our secondary objective is to provide a mathematical foundation for 'graviton condensates' in the framework of the Renormalization Group and to show that the Schwarzschild geometry emmerges from higher order corrections of the quantized action for the graviton field.
Regarding future work, we seek to generalize this LSZ approach to other processes (black hole mergers, inspirals etc) and recover the energy spectrum of the emitted GWs.

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