

# On the existence of non-perturbative gravitational waves on space-time boundaries

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## Abstract

We consider the existence of non-perturbative gravitational waves on space-time boundaries of a Schwarzschild black hole. The solution to the Einstein equations for the black hole is found to be non-perturbative, i.e. it is proportional to the square of the horizon radius. The existence of gravitational waves over the horizon radius is known to be of the same type as the existence of gravitational waves on the original horizon. The problems of mixing and scattering of gravitational waves are solved in the same way, i.e. the effect of gravitational waves is determined by the position of the black hole. We find that the space-time boundary cannot contain gravitational waves, but it does contain the gravitational waves. The result shows that if the space-time boundary is a flat space, the gravitational waves cannot be present on space-time.