Alice, when falling into a black hole, cannot communicate anymore with Rob

There is the physical situation of two observers, Alice and (Anti)Rob, one of which, Alice, is inertial, while the other one, (Anti)Rob, is uniformly accelerated, see Fig.1.

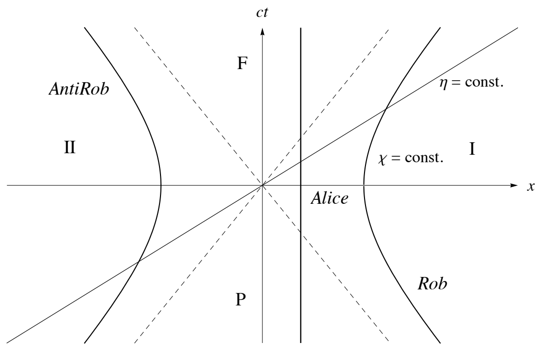

Figure 1

The uniformly accelerated observers Rob and AntiRob are confined to the Rindler wedges I ($|t| < x$) and II ($|t| < -x$) respectively, which are causally disconnected from each other. Their worldlines are hyperbolas, which correspond to lines of constant $\chi = c^2/a$, where a is their proper acceleration.

To describe the point of view of an accelerated observer the so-called Rindler coordinates are introduced, which are the proper coordinates of an accelerated observer moving with fixed acceleration.

Both observers share a maximal entangled state of two fermions, where the entanglement decreases for increasing acceleration. The surviving entanglement, in infinitely accelerated frame, however, cannot be used to violate the CHSH inequality, which is the optimal Bell inequality for this situation. Therefore no quantum information tasks using these correlations can be performed !

This is especially important not only for the results in the infinite acceleration limit but also if we identify this limit with a black hole situation, where an observer is freely falling and another observer is resting arbitrarily close to the event horizon. Alice, when falling into a black hole, cannot communicate on a quantum information level with an observer who is resting near the horizon. Thus quantum mechanics cannot overcome relativity !

Residual entanglement of accelerated fermions is not nonlocal
N. Friis, P. Köhler, M. Martin-Martinez, R.A. Bertlmann, Phys.Rev.A**84**,062111 (2011) and arXiv:1107.3235 [quant-ph]