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The small sphere limits of quasilocal masses in higher dimensions

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The problem of quasilocal mass has been extensively studied mainly in four dimensions. Here we report results regarding several quasilocal mass proposals in spacetime dimensions $n \geq 4$. After generalising three distinct quasilocal mass definitions to higher dimensions under appropriate assumptions, we evaluate their small sphere limits along lightcone cuts shrinking towards the lightcone vertex. The results in vacuum are conveniently represented in terms of the electromagnetic decompositions of the Weyl tensor. We find that the limits at presence of matter yield the stress tensor as expected, but the vacuum limits are in general not proportional to the Bel-Robinson superenergy Q in dimensions $n > 4$. The result defies the role of the Bel-Robinson superenergy as characterising the gravitational energy in higher dimensions, albeit the fact that it uniquely generalises. Surprisingly, the Hawking energy and the Brown-York energy exactly agree upon the small sphere limits across all dimensions. The new vacuum limit W, however, cannot be interpreted as a gravitational energy because of its non-positivity. Furthermore, we also give the small sphere limits of the Kijowski-Epp-Liu-Yau type energy in higher dimensions, and again we see W in place of Q.

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