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## A lutetium frequency reference.

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Singly ionized lutetium ( $^{176}\text{Lu}^+$ ) has a unique level structure that provides multiple clock transitions. In combination with hyperfine averaging, two of these transitions ( $^1S_0 - ^3D_1$  &  $^1S_0 - ^3D_2$ ) present both a long lifetime and low sensitivity to the electromagnetic environment, which allows high performance clock operation on both transitions. Recently we have demonstrated clock comparison on the  $^1S_0 - ^3D_1$  at the low  $10^{-18}$  level limited by clock stability, with an error budget that supports the capability to go well beyond  $10^{-18}$ .

The relative ease at which we are able to establish agreement between two independent frequency references is attractive both for applications and establishing a laboratory frequency reference. We discuss the advantages that lutetium offers with an emphasis on the unique possibilities afforded by the existence of two transitions within the one system. In particular, a frequency ratio measured within the one system provides an independent metric that can validate performance claims made on a single transition.

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