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Precision measurement of the positive muon lifetime by the MuLan collaboration

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The Fermi constant $G_{\rm F}$ governs the rates of all weak interaction processes and, along with the fine structure constant α and the Z-boson mass M_Z, it is one of the principal input parameters to the Standard Model. Owing to the purely leptonic nature of the muon decay process, $G_{\rm F}$ is extracted most precisely from measurements of the muon lifetime τ_μ. In 1999, the publication of missing radiative corrections effectively eliminated the largest, purely theoretical uncertainty in extracting $G_{\rm F}$ from τ_μ. At present, the precision in $G_{\rm F}$ is limited by experimental uncertainty in τ_μ. We report a measurement of the positive muon lifetime to a precision of one part-per-million, a better than twenty-fold improvement over the previoius generation of experiments. The new result will improve precision in G_F to better than 0.8 parts-per-million. The MuLan experiment was conducted at the Paul Scherrer Institute in Villigen, Switzerland, using a pulsed surface muon beam, in-vacuum muon-stopping targets, and a large acceptance, finely segmented scintillator array. We will describe our measurement method and report our final result.

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