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New Singlet Positronium Bound State HORACE CRATER, The University of Tennessee Space Institute, CHEUK-YIN WONG, Oak Ridge National Laboratory — The Two-Body Dirac equations of constraint dynamics applied to QED yield an exact Sommerfeld-like solution for the spectrum of ${}^1J_J$ singlet positronium states which agrees with standard perturbative results through order α^4. At short distance the bound state equation is $(-d^2/dr^2 + (J(J+1) - \alpha^2)/r^2)u = 0$, and the radial part of the wave function $u = r\psi$ has two solutions with probabilities near the origin of $\psi^2 d^3r = u^2 dr d\Omega = r^{(1\pm\sqrt{(2J+1)^2-4a^2})} dr d\Omega$. For $J \neq 0$ only the '+' sign is allowable but both signs for $J = 0$ are well behaved. The '+' sign corresponds to ordinary positronium (with a binding energy of about 6.8 eV). The '$-$' sign corresponds to a new positronium state with a binding energy of about 300 KeV and size about a electron Compton wave length. The ordinary $1S$ positronium state decays into this new $1S$ state with a life time on the order of 10^{-3} seconds by two photon emission with c.m. energy of about 700 KeV. The peculiar $1S$ state then annihilates into two photons with c.m. energy of about 300 KeV. Thus the existence of this new positronium state would be a distinctive 4 gamma decay signature of ordinary singlet positronium.

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