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Verifying the Resonance Schemes of Unstable Particles at Lepton Colliders

We propose practical ways of differentiating the various (Breit-Wigner, theoretical, and energy-dependent) resonance schemes of unstable particles at lepton colliders. First, the energy-dependent scheme can be distinguished from the other two by fitting the Z lineshape scan and forward-backward asymmetries at LEP and future lepton colliders with the Z mass m_Z, decay width Γ_Z, and coupling strength as fitting parameters. Although the Breit-Wigner and theoretical schemes work equally well, the scheme conversion requires the decay width Γ_Z to scale inversely with m_Z rather than the usual linear dependence from theoretical calculation. These contradicting behaviors can be used to distinguish the Breit-Wigner and theoretical schemes by the precision Z measurements with single parameter (m_Z) fit at future lepton colliders. For the WW threshold scan, its combination with the precise Fermi constant provides another way of distinguishing the Breit-Wigner and theoretical schemes.

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