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Reconciling CME Kinematics using Radio and White-light Observations from STEREO and SOHO

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We study the characteristics of nonthermal radio emission associated with coronal mass ejections (CMEs) observed by STEREO, SOHO, and Wind spacecraft. In particular, we examine three backside CMEs associated with type II radio bursts at frequencies below 16 MHz. These bursts are known to be excellent indicators of solar energetic particle events. We use the universal drift rate spectrum of type II radio bursts and the inferred density scale heights in the corona and interplanetary medium o estimate the speed of the shock waves that produce the type II radio bursts. We find that the radio bursts can provide an accurate estimate of the CME speeds. We consider three backside events and a cannibalism event to show the usefulness of radio dynamic spectrum in inferring CME kinematics. We use radio direction finding technique to show that CME-CME interaction results in enhanced nonthermal radio emission. The radio data also provide constraints on the particle acceleration mechanisms and the reason for the energetic particles observed at wide-ranging longitudes. Finally we infer the shape and extent of the shock associated with one of the biggest solar energetic particle events in the space era.