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A new procedure of shock fittings to the MHD Rankine-Hugoniot relations: application to interplanetary shocks

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In study the MHD shock-discontinuity interactions, it is essential to use accurate shock parameters in the analysis. These shock parameters are derived from the Rankine-Hugoniot (RH) relations based on observed solar wind plasmas and magnetic fields on both sides of the shock. In this study, we present a novel procedure of shock fitting. To minimize the difficulties due to the uncertainty of the shock frame reference and fluctuations of the vector quantities of solar wind velocity and magnetic field, we choose only the scalar parameters m, θ_{BN}, y ,β_1, and β_2 to fit the RH shock jump relations, where $m = B_2/B_1$ and $y = n_1/n_2$ are the ratio of magnetic field strength and solar wind proton number density across the shock, and $\beta = P/(B^2/2\mu_0)$ is the ratio of thermal energy over magnetic energy. The θ_{BN} is the angle between the shock normal and upstream magnetic field, B_1 derived from the shock coplanarity theorem. With these five scalar parameters and heat flow and normal momentum flux due to waves and/or turbulence on both sides of the shock, we propose a procedure to derive a set of best-fit values to the RH relations. The estimated flow velocity and shock speed agrees very well with observations. Applications of this procedure to 17 interplanetary shocks are demonstrated in this study. We found that for quasi-parallel or large beta shocks an additional amount of heat flow and normal momentum flux are needed in order to satisfy the shock jump relations. However, two of the quasi-parallel shocks require opposite direction of heat flow and normal momentum flux in comparison with the other shocks. We suggest strong heat-flow and waves in the

Earth’s foreshock region cause this difference.