The Mathematical Structure of
Cell Centered Lagrangian Compressible Schemes

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The integral formulation of Lagrangian equations for compressible gas

dynamics writes

\[ \begin{align*}
\frac{D}{Dt} \int_{V_j(t)} \rho \, dV &= 0, & \text{mass conservation,} \\
\frac{D}{Dt} \int_{V_j(t)} \rho u \, dV + \int_{S_j(t)} p n \, dS &= 0, & \text{momentum conservation,} \\
\frac{D}{Dt} \int_{V_j(t)} \rho e \, dV + \int_{S_j(t)} p u n \, dS &= 0, & \text{total energy conservation,} \\
\frac{D}{Dt} \int_{V_j(t)} dV - \int_{S_j(t)} u n \, dS &= 0, & \text{volume conservation.}
\end{align*} \]

An important research work is nowadays devoted to the understanding of the
mathematical structure of the equations (it must be noted that Lagrangian
equations for compressible gas dynamics are only weakly hyperbolic), and
also to the design of new Lagrangian numerical schemes.

I will discuss recent advances that have been made on the numerical
structure of Godunov like cell-centered Lagrangian methods for the solution
of this problem, focusing on multiD formulation, stability issues and entropy
properties of the numerical methods.

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