Abstract Submitted
for the NWS15 Meeting of
The American Physical Society

Classical and Quantum Spin Angular Momentum ROBERT CLOSE, Clark College — Classical (orbital) angular momentum density ($\mathbf{r} \times \mathbf{p}$) is defined in terms of momentum density ($\mathbf{p}$) relative to an arbitrary choice of origin ($\mathbf{r} = 0$). It is also possible to define a classical spin angular momentum density (or spin density) as the field whose curl is equal to twice the momentum density of incompressible motion ($\nabla \times \mathbf{S} = 2\mathbf{p}$). Integration by parts shows that the two definitions of angular momentum density yield equivalent results for total angular momentum and kinetic energy. Applying classical spin density to the description of elastic waves yields a nonlinear Dirac equation whose momentum and angular momentum operators are equivalent to those found in relativistic quantum mechanics. Particle-like solutions of this equation would have physical properties similar to matter.

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Date submitted: 27 Mar 2015 Electronic form version 1.4