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Structure-preserving geometric algorithms for plasma physics and beam physics HONG QIN, Princeton University and University of Science and Technology of China — Standard algorithms in the plasma physics and beam physics do not possess the long-term accuracy and fidelity required in the study of multi-scale dynamics, because they do not preserve the geometric structures of the physical systems, such as the local energy-momentum conservation, symplectic structure and gauge symmetry. As a result, numerical errors accumulate coherently with time and long-term simulation results are not reliable. To overcome this difficulty, since 2008 structure-preserving geometric algorithms have been developed [1-11]. This new generation of algorithms utilizes advanced techniques, such as interpolating differential forms [3,5], canonical [7] and non-canonical [5,6] symplectic integrators, and finite element exterior calculus [8] to guarantee gauge symmetry and charge conservation[3,5], and the conservation of energy-momentum [3,4,5-11] and symplectic structure [1,3,4,5-11]. It is our vision that future numerical capabilities in plasma physics and beam physics will be based on the structure-preserving geometric algorithms. Refs.: [1]H. Qin et al., PRL 100, 035006 (2008). [2]H. Qin et al., PoP 20, 084503 (2013). [3]J. Squire et al., PoP 19, 084501 (2012). [4]J. Xiao et al., PoP 20, 102517 (2013). [5]Y. Zhou et al., PoP 21, 102109 (2014). [6]J. Xiao et al., PoP 22, 112504 (2015). [7]Y. He et al., PoP 22,124503 (2015). [8]H. Qin et al., NF 56, 014001 (2016). [9]Y. He, et al., PoP 23, 092108, (2016). [10]J. Xiao et al., PoP 23, 112107 (2016). [11] J.Xiao et al., PoP 24, 062112 (2017).

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