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Simulations of global-scale dynamo action in the Sun and other stars[1]

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Our Sun is a magnetic star, and its eleven-year cycles of magnetic activity profoundly affect our modern technological society. The magnetic fields we see at the solar surface are built by dynamo processes in the Sun's sub-surface convection zone. There, global-scale plasma motions couple with rotation to build and rebuild the global-scale magnetic fields and drive cycles of magnetic activity, though the exact processes at work in solar and stellar dynamos remain elusive. The Sun is not the only magnetic star: indeed magnetism is a ubiquitous feature of stars that have convection zones near their surfaces. Observations of younger suns indicate that they rotate quite rapidly, have strong magnetic fields at their surfaces, and show signs of cyclic activity. Here we explore recent 3-D MHD simulations of the solar dynamo and of stellar dynamos in younger, more rapidly rotating solar-type stars. These are conducted with the anelastic spherical harmonic (ASH) code on modern supercomputers. These simulations of global-scale convection and dynamo action produce strikingly organized magnetic structures in the bulk of their convection zones. Wreaths of magnetic field fill the convection zone and can undergo regular cycles of polarity reversal. Indeed, we find that cyclic behavior is a common feature throughout the parameter space we have explored. Simulations like these are providing new views on the phenomena of solar and stellar dynamo action.

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