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Hairpin exact coherent states in channel flow MICHAEL GRAHAM, University of Wisconsin-Madison, ASHWIN SHEKAR, Department of Chemical and Biological Engineering, University of Wisconsin-Madison — Questions remain over the role of hairpin vortices in fully developed turbulent flows. Studies have shown that hairpins play a role in the dynamics away from the wall but the question still persists if they play any part in (near wall) fully developed turbulent dynamics. In addition, the robustness of the hairpin vortex regeneration mechanism is still under investigation. Recent studies have shown the existence of nonlinear traveling wave solutions to the Navier-Stokes equations, also known as exact coherent states (ECS), that capture many aspects of near-wall turbulent structures. Previously discovered ECS in channel flow have a quasi-streamwise vortex structure, with no indication of hairpin formation. Here we present a family of traveling wave solutions for channel flow that displays hairpin vortices. They have a streamwise vortex –streak structure near the wall with a spatially localized hairpin head near the channel centerline, attached to and sustained by the near wall structures. This family of solutions emerges through a transcritical bifurcation from a branch of traveling wave solutions with y and z reflectional symmetry. We also look into the instabilities that lead to the development of hairpins also explore its connection to turbulent dynamics.

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