

Karl R. Helfrich

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B. S. E., Duke University, 1979
S. M., Massachusetts Institute of Technology, 1982
Ph.D., Massachusetts Institute of Technology, 1985

Postdoctoral Investigator, 1985,
Department of Civil Engineering,
Massachusetts Institute of Technology.

Postdoctoral Fellow, 1985–1986;
Postdoctoral Investigator, 1986–1987;
Assistant Scientist, 1987–1991;
Associate Scientist, 1991–2000, tenure awarded, 1995;
Senior Scientist, 2000–present,
Department of Physical Oceanography,
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Member, American Geophysical Union, American Meteorological Society, American Physical Society.

Fellow, American Physical Society, 2001.

Henry Bryant Bigelow Chair for Excellence in Oceanography, 2014–17.

Faculty member of the Geophysical Fluid Dynamics Summer Program.

Research Interests: Theoretical, numerical and laboratory studies in geophysical fluid dynamics: stratified flows, nonlinear internal waves and tides, hydraulic phenomena, abyssal circulation in the presence of topography, geological fluid dynamics, bio-fluid dynamics.

Refereed Publications:

Helfrich, K. R., W. K. Melville, and J. W. Miles, 1984. On interfacial solitary waves over variable topography. *Journal of Fluid Mechanics*, **149**, 305–317.

Helfrich, K. R., and W. K. Melville, 1986. On long nonlinear internal waves over slope–shelf topography. *Journal of Fluid Mechanics*, **167**, 285–308.

Whitehead, J. A., and K. R. Helfrich, 1986. The Korteweg–de Vries equation from laboratory conduit and magma migration equations. *Geophysical Research Letters*, **13**, 545–546.

Melville, W. K., and K. R. Helfrich, 1987. Transcritical two-layer flow over topography. *Journal of Fluid Mechanics*, **178**, 31–52.

- Helfrich, K. R., and U. Send, 1988. Finite-amplitude evolution of two-layer geostrophic vortices. *Journal of Fluid Mechanics*, **197**, 331–348.
- Whitehead, J. A., and K. R. Helfrich, 1988. Wave transport of deep mantle material. *Nature*, **336**, 59–61.
- Helfrich, K. R., and J. A. Whitehead, 1989. Solitary waves on conduits of buoyant fluid in a more viscous fluid. *Geophysical and Astrophysical Fluid Dynamics*, **51**, 35–52.
- Adams, E. E., D. J. Cosler, and K. R. Helfrich, 1990. Evaporation from heated water bodies: predicting combined force plus free convection. *Water Resources Research*, **26**(3), 425–435.
- Helfrich, K. R., and W. K. Melville, 1990. Review of dispersive and resonant effects in internal wave propagation. *The Physical Oceanography of Sea Straits*, L. J. Pratt, editor, NATO/ASI Series, Kluwer Academic Publishers, Dordrecht; pp. 391–420.
- Whitehead, J. W., and K. R. Helfrich, 1990. Magma waves and diapiric dynamics. *Magma Transport and Storage*, Michael L. Ryan, editor, John Wiley & Sons, Chichester, pp. 53–76.
- Helfrich, K. R., and T. M. Battisti, 1991. Experiments on baroclinic vortex shedding from hydrothermal plumes. *Journal of Geophysical Research*, **96**(C7), 12,511–12,518.
- Whitehead, J. A., and K. R. Helfrich, 1991. Instability of flow with temperature-dependent viscosity: A model of magma dynamics. *Journal of Geophysical Research*, **96**(B3), 4145–4155.
- Grimshaw, R. H. J., K. R. Helfrich, and J. A. Whitehead, 1992. Conduit solitary waves in a visco-elastic medium. *Geophysical and Astrophysical Fluid Dynamics*, **65**, 127–147.
- Helfrich, K. R., 1992. Internal solitary wave breaking and run-up on a uniform slope. *Journal of Fluid Mechanics*, **243**, 133–154.
- Helfrich, Karl R., and Joseph Pedlosky, 1993. Time-dependent isolated anomalies in zonal flows. *Journal of Fluid Mechanics*, **251**, 377–409.
- Helfrich, K. R., 1994. Thermals with background rotation and stratification. *Journal of Fluid Mechanics*, **259**, 265–280.
- Kim, S. L., L. S. Mullineaux, and K. R. Helfrich, 1994. Larval dispersal via entrainment into hydrothermal vent plumes. *Journal of Geophysical Research*, **99**(C6), 12655–12665.
- Grimshaw, R. H. J., and K. R. Helfrich, 1995. Solitary waves on two-dimensional slab conduits of buoyant fluid in a more viscous fluid. *Geophysical and Astrophysical Fluid Dynamics*, **79**, 223–238.
- Helfrich, K. R., 1995. Thermo-viscous fingering of flow in a thin gap: A model of magma flow in dikes and fissures. *Journal of Fluid Mechanics*, **305**, 219–238.
- Helfrich, K. R., 1995. Time-dependent two-layer hydraulic exchange flows. *Journal of Physical Oceanography*, **25**(3), 359–373.
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- Speer, K. G., and K. R. Helfrich, 1996. Hydrothermal plumes: A review of flow and fluxes. In: *Hydrothermal Vents and Processes*, L. M. Parson, C. L. Walker, and D. R. Dixon, Editors, Geological Society Special Publication No. 87, pp. 373–386.
- Pedlosky, J., L. J. Pratt, M. A. Spall, and K. R. Helfrich, 1997. Circulation around islands and ridges. *Journal of Marine Research*, **55**, 1199–1251.
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- Wylie, J. J., K. R. Helfrich, B. Dade, J. R. Lister, and J. F. Salzig, 1999. Flow localization in fissure eruptions. *Bulletin of Volcanology*, **60**, 432–440.
- Pratt, L. J., K. R. Helfrich, and E. Chassignet, 2000. Hydraulic adjustment to an obstacle in a rotating channel. *Journal of Fluid Mechanics*, **404**, 117–149.
- Wells, J. R., and K. R. Helfrich, 2001. Circulation around a thin zonal island. *Journal of Fluid Mechanics*, **37**, 301–323.
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- Lentz, S. J., and K. R. Helfrich, 2002. Buoyant gravity currents along a sloping bottom in a rotating fluid. *Journal of Fluid Mechanics*, **464** 251–278.
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- Stern, M. E., and K. R. Helfrich, 2002. Propagation of a finite-amplitude potential vorticity front along the wall of a stratified fluid. *Journal of Fluid Mechanics*, **468**, 179–204.
- Helfrich, K. R., and J. Pineda, 2003. Accumulation of particles in propagating fronts. *Limnology and Oceanography*, **48**(4), 1509–1520.
- Helfrich, K. R., and L. J. Pratt, 2003. Rotating hydraulics and upstream basin circulation. *Journal of Physical Oceanography*, **33**, 1651–1663.
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- Helfrich, K. R., and B. L. White, 2010. A model of internal solitary waves with trapped cores. *Nonlinear Processes in Geophysics*, **17**, 303–318.
- Ostrovsky, L., and K. R. Helfrich, 2011. Strongly nonlinear, simple internal waves in continuously-stratified, shallow fluids. *Nonlinear Processes in Geophysics*, **18**, 91–102.
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- Grimshaw, R. H. J., and K. R. Helfrich, 2012. The effect of rotation on internal solitary waves. *IMA J. Appl. Maths.*, doi: 10.1093/imamat/hxs024.
- Grimshaw, R., K. Helfrich and E. R. Johnson, 2012. The reduced Ostrovsky equation: integrability and breaking. *Std. Appl. Math.* **129**, 414–436.
- White, B. L., and K. R. Helfrich, 2012. A general description of a gravity current front propagating in a two-layer stratified fluid. *Journal of Fluid Mechanics*, **711**, 545–575.
- White, B. L., and K. R. Helfrich, 2013. Rapid gravitational collapse of a horizontal shear layer. *Journal of Fluid Mechanics*, **721**, 86–117.
- Grimshaw, R., K. Helfrich and E. R. Johnson 2013. Experimental study of the effect of rotation on nonlinear internal waves. *Phys. Fluids* **25**, 056602, doi:10.1063/1.4805092.
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- White, B. L. and K. R. Helfrich 2014. Internal bores in continuous stratifications. *J. Fluid Mech.* **761**, 282–304.
- Alford, M. H., T. Peacock, *et al.* 2015. The formation and fate of internal waves in the South China Sea. *Nature* **521**, 65–69. doi:10.1038/nature14399.
- Wheeler, J. D., K. R. Helfrich, E. J. Anderson and L. S. Mullineaux 2015. Isolating the hydrodynamic triggers of the diver response in the larval eastern oyster (*Crassostrea virginica*), *Limnology & Oceano.* **60**, 1332–1343.
- Pineda, J. V. Starczak, J. da Silva, K. Helfrich, M. Thompson and D. Wiley 2015. Whales and waves: humpback whale foraging response and the shoaling of internal waves at Stellwagen Bank. *J. Geophys. Res.* **120**, doi:10.1002/2014JC010564.
- Ogden, K. A. and K. R. Helfrich 2016. Internal hydraulic jumps in two-layer flows with upstream shear. *J. Fluid Mech.* **789**, 64–92, doi:10.1017/jfm.2015.727.
- Wheeler, J. D , E. Lou, K. R. Helfrich, E. J. Anderson, V. R. Starczak, and L. S. Mullineaux 2017. Light stimulates swimming behavior of larval eastern oysters *Crassostrea virginica* in turbulent. *Mar. Ecology Prog. Series* **571**, 109–120. doi:10.3354/meps12106.
- Grimshaw, R. and K. R. Helfrich 2018. Internal solitary wave generation by tidal flow over topography. *J. Fluid Mech.* **839**, 387–407. doi:10.1017/jfm.2018.21.
- Passaggia, P.-Y., K. R. Helfrich and B. L. White 2018. Optimal transient growth in thin-interface internal solitary waves. *J. Fluid Mech.* **840**, 342–378. doi:10.1017/jfm.2018.19.

Non-refereed Publications

- Pratt, L. J., and K. R. Helfrich, 1990. Current research problems. *The Physical Oceanography of Sea Straits*, L. J. Pratt, editor, Kluwer, Dordrecht; pp. 577–580.
- Helfrich, K. R., 1987. Experiments on baroclinic eddy evolution and stability in continuously stratified systems. Proceedings of the *Third International Conference on Stratified Flows*, California Institute of Technology, Pasadena, California, February 1987.
- Helfrich, K. R., 2001. Dispersion from hydrothermal vents. In: *Encyclopedia of Ocean Sciences*, John H. Steele, Steve A. Thorpe, and Karl K. Turekian, Editors, Academic Press, San Diego, **2**, 733–741.
- Helfrich, K. R., and L. J. Pratt, 2002. Rotating hydraulics and upstream basin circulation. In electronic *Proceedings of the 2nd Meeting on the Physical Oceanography of Sea Straits*, Villefranche, France, April 15–19, 2002.
- Helfrich, K.R., R. Grimshaw and T. Johnson, 2010. Effect of rotation on internal solitary waves. Proceedings of HYDRALAB-III, Hannover, Germany, February 2–3, 2010.
- Grimshaw, R., K. R. Helfrich, and A. Scotti. Large-amplitude internal waves in the ocean. *Nonlin. Proc. Geophys.*, in preparation. (Overview note for a special issue by the co-editors).

Thesis

- Helfrich, K. R. 1981. Evaluation of models for predicting evaporative water loss in cooling impoundments. M.S. Thesis, Massachusetts Institute of Technology, 157 pp.
- Helfrich, K. R., 1985. On long nonlinear internal waves over bottom topography. Ph.D. Thesis, Massachusetts Institute of Technology, 272 pp.