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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,  
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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-

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.
- Helfrich, K. R., and J. Pedlosky, 1995. Large-amplitude coherent anomalies in baroclinic zonal flows. *Journal of the Atmospheric Sciences*, **52**, 1615–1629.
- Helfrich, K. R., and K. G. Speer, 1995. Oceanic hydrothermal circulation: mesoscale and basin-scale flow. *AGU Monograph 91, Seafloor Hydrothermal Systems Physical, Chemical, Biological, and Geological Interactions*, 347–356.

- 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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- Helfrich, K. R., J. Pedlosky, and E. Carter, 1999. The shadowed island. *Journal of Physical Oceanography*, **29**, 2559–2577.
- 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.
- Deese, H. E., L. J. Pratt, and K. R. Helfrich, 2002. A laboratory model of exchange and mixing between western boundary layers and sub-basin recirculation gyres. *Journal of Physical Oceanography*, **32**, 1870–1889.
- 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.
- Miller, P. D., L. J. Pratt, K. R. Helfrich, and C. K. R. T. Jones, 2002. Chaotic transport of mass and potential vorticity for an island recirculation. *Journal of Physical Oceanography*, **32**, 80–102.
- 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.
- Holtegard-Neilsen, M., L. J. Pratt, and K. R. Helfrich, 2004. Mixing and entrainment in hydraulically-driven, stratified sill flows. *Journal of Fluid Mechanics*, **15**, 415–443.
- Siddall, M., L. J. Pratt, K. R. Helfrich, and L. Giosan, 2004. Testing the physical implications of the sudden Black Sea infill 8400 years ago. *Paleoceanography*, **19**, PA1024, doi:10.1029/2003PA000903.

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- Helfrich, K. R., and R. H. J. Grimshaw, 2008. Nonlinear disintegration of the internal tide. *Journal of Physical Oceanography*, **38**, 686-701.
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- Grimshaw, R., and K. R. Helfrich, 2008. Long-time solutions of the Ostrovsky equation. *Studies in Applied Mathematics*, **121**, 71-88.
- Helfrich, K. R., 2008. Continuously stratified nonlinear low-mode internal tides. *Journal of Marine Research*, **25**, 299-323.
- White, B. L., and K. R. Helfrich, 2008. Gravity currents and internal waves in a continuously stratified fluid. *Journal of Fluid Mechanics*, **616**, 327-356.
- Da Silva, J. C. B., and K. R. Helfrich, 2008. Synthetic aperture radar observations of resonantly generated internal solitary waves at Race Point Channel (Cape Cod), *Journal of Geophysical Research*, **113**, C11016, doi: 10.1029/2008JC005004.
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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.
- DiBacco, C., H. L. Fuchs, J. Pineda, and K. R. Helfrich, 2011. Swimming behavior and velocities of barnacle cyprides in a downwelling flume. *Marine Ecology Prog. Series*, **433**, 131-148.

- 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.
- Wheeler, J. D ,K. R. Helfrich, E. J. Anderson, B.McGann, P. Staats, A. E. Wargula, K. Wilt, and L. S. Mullineaux. 2013. Upward swimming of competent oyster larvae (*Crassostrea virginica*) persists in highly turbulent flow as detected by PIV flow subtraction. *Mar. Ecology Prog. Series* **488**, 171-185. DOI: 10.3354/meps10382.
- Mercier, M., L. Gostiaux, K. Helfrich, J. Sommeria, S. Viboud, H. Didelle, Sasan J. Ghaemsaïdi, T. Dauxois and T. Peacock, 2013. Large-scale, realistic laboratory modeling of the  $M_2$  internal tide generation at the Luzon Strait. *Geophys. Res. Lett.*, **40**, 5704-5709.
- Grimshaw, R., C. Guo, K. Helfrich and V. Vlasenko. Combined effect of rotation and topography on shoaling oceanic internal solitary waves. *J. Phys. Oceano.*, in press.
- Luzzatto-Fegiz, P. and K. R. Helfrich. Laboratory experiments and simulations for solitary internal waves with trapped cores. *J. Fluid Mech.* **757**, 354-380, doi:10.1017/jfm.2014.501.
- White, B. L. and K. R. Helfrich. 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.
- J. D. Wheeler, K. R. Helfrich, E. J. Anderson and L. S. Mullineaux. Isolating the hydrodynamic triggers of the diver response in the larval eastern oyster (*Crassostrea virginica*), *Limnology & Oceano.*, accepted.
- Pineda, J. V. Starczak, J. da Silva, K. Helfrich, M. Thompson and D. Wiley. Whales and waves: humpback whale foraging response and the shoaling of internal waves at Stellwagen Bank. *J. Geophys. Res.* accepted.
- Lou, E. Y., J. D. Wheeler, K. R. Helfrich E. J. Anderson and L. S. Mullineaux. Light stimulates behavior of larval eastern oysters (*Crassostrea virginica*) in turbulent flow. *Mar. Ecol. Prog. Ser.*, submitted.
- Ogden, K. A. and K. R. Helfrich. Internal hydraulic jumps in two-layer flows with upstream shear. *JFM*, submitted.

### 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 2<sup>nd</sup> 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.
- Mullineaux, L. S., K. R. Helfrich, E. Anderson, P. Statts, A. Wargula, and K. Wilt. Swimming and diving of the oyster larvae (*Crassostera virginica*). *MEPS*, in preparation.
- 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.