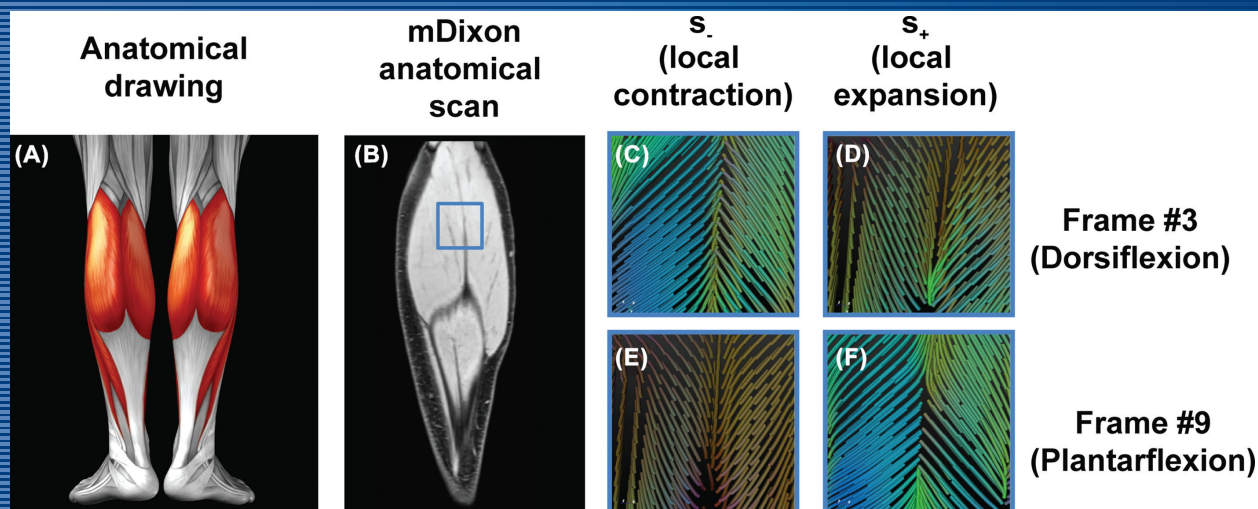


# MAGNETIC RESONANCE IN MEDICINE



Color-coded strain rate images from an ROI in the gastrocnemius muscle, from the article by Mazzoli et al. (pp. 1799-1811).

# Magnetic Resonance in Medicine

EDITOR-IN-CHIEF

**Matt A. Bernstein**

*Rochester, MN, USA*

DEPUTY EDITORS

**Daniel Alexander**  
*London, United Kingdom*

**Peter B. Barker**  
*Baltimore, MD, USA*

**Paul A. Bottomley**  
*Baltimore, MD, USA*

**Richard W. Bowtell**  
*Nottingham, United Kingdom*

**Peter Caravan**  
*Charlottesville, VA, USA*

**Mara Cercignani**  
*Brighton, United Kingdom*

**Stuart Crozier**  
*Brisbane, Australia*

**Yiping Du**  
*Shanghai, China*

**Daniel B. Ennis**  
*Los Angeles, CA, USA*

**Frederick H. Epstein**  
*Charlottesville, VA, USA*

**Thomas Ernst**  
*Honolulu, HI, USA*

**William Grissom**  
*Nashville, TN, USA*

**Alexej Jerschow**  
*New York, NY, USA*

**Peter Jezzard**  
*Oxford, United Kingdom*

**Mark E. Ladd**  
*Heidelberg, Germany*

**Seung-Kyun Lee**  
*Suwon, Korea*

**Zhi-Pei Liang**  
*Champaign, IL, USA*

**Andrew A. Maudsley**  
*Miami, FL, USA*

**Karla Miller**  
*Oxford, United Kingdom*

**Jon-Fredrik Nielsen**  
*Ann Arbor, MI, USA*

**Geoff J.M. Parker**  
*Manchester, United Kingdom*

**Giles E. Santyr**  
*Toronto, Ontario, Canada*

**Oliver Speck**  
*Magdeburg, Germany*

**Nikola A. Stikov**  
*Scientific Outreach  
Montreal, Quebec, Canada*

**Joshua Trzasko**  
*Rochester, MN, USA*

**Andrew Webb**  
*Leiden, The Netherlands*

**Leslie Ying**  
*Buffalo, NY, USA*

ASSOCIATE EDITORS

**David Alsop**  
*Boston, MA, USA*

**Richard L. Ehman**  
*Rochester, MN, USA*

**R. Mark Henkelman**  
*Toronto, Ontario, Canada*

**Jürgen Hennig**  
*Freiburg, Germany*

**Xiaoping P. Hu**  
*Atlanta, GA, USA*

**Debiao Li**  
*Los Angeles, CA, USA*

**Robert Turner**  
*Leipzig, Germany*

**Peter C.M. van Zijl**  
*Baltimore, MD, USA*

**Felix W. Wehrli**  
*Philadelphia, PA, USA*

**Richard R. Ernst**  
*Zurich, Switzerland*

**Erwin L. Hahn**  
*In Memoriam*

**E. Raymond Andrew**  
*In Memoriam*

**Michael B. Smith**  
*Cambridge, MA, USA*

HONORARY MEMBERS

**Paul C. Lauterbur**  
*In Memoriam*

**Sir Peter Mansfield**  
*In Memoriam*

EDITORS EMERITUS

**Felix W. Wehrli**  
*Philadelphia, PA, USA*

EDITORIAL BOARD

**Joseph J. H. Ackerman**  
*Saint Louis, MO, USA*

**Yaniv Assaf**  
*Tel Aviv, Israel*

**Ergin Atalar**  
*Ankara, Turkey*

**David O. Brunner**  
*Zürich, Switzerland*

**David L. Buckley**  
*Leeds, United Kingdom*

**Jeff W. M. Bulte**  
*Baltimore, MD, USA*

**Kim Butts Pauly**  
*Stanford, CA, USA*

**Fernando Calamante**  
*Camperdown, Australia*

**R. Todd Constable**  
*New Haven, CT, USA*

**Jeff Duyn**  
*Bethesda, MD, USA*

**Jens Frahm**  
*Göttingen, Germany*

**Daniel Gallichan**  
*Cardiff, United Kingdom*

**Gary H. Glover**  
*Stanford, CA, USA*

**Penny A. Gowland**  
*Nottingham, United Kingdom*

**Mark A. Griswold**  
*Cleveland, OH, USA*

**Brian Hargreaves**  
*Stanford, CA, USA*

**Anke Henning**  
*Tübingen, Germany*

**Houchun Hu**  
*Columbus, OH, USA*

**Derek K. Jones**  
*Cardiff, United Kingdom*

**Dong-Hyun Kim**  
*Seoul, Republic of Korea*

**Roland Kreis**  
*Bern, Switzerland*

**Vivian S. Lee**  
*Salt Lake City, UT, USA*

**Xiaojuan Li**  
*Cleveland, OH, USA*

**Dong Liang**  
*Shenzhen, China*

**Fa-Hsuan Lin**  
*Taipei, Taiwan*

**Silvia Mangia**  
*Minneapolis, MN, USA*

**Mary P. McDougall**  
*College Station, TX, USA*

**John P. Mugler**  
*Charlottesville, VA, USA*

**Reza Nezafat**  
*Boston, MA, USA*

**Douglas C. Noll**  
*Ann Arbor, MI, USA*

**Jullie W. Pan**  
*New Haven, CT, USA*

**John Pauly**  
*Stanford, CA, USA*

**Dana C. Peters**  
*New Haven, CT, USA*

**James G. Pipe**  
*Phoenix, AZ, USA*

**Martin R. Prince**  
*New York, NY, USA*

**Klaas P. Pruessmann**  
*Zürich, Switzerland*

**Caroline Rae**  
*Randwick, Australia*

**Scott B. Reeder**  
*Madison, WI, USA*

**Stephen J. Riederer**  
*Rochester, MN, USA*

**Alexey Samsonov**  
*Madison, WI, USA*

**Klaus Scheffler**  
*Tübingen, Germany*

**Mark Schweitzer**  
*Stony Brook, NY, USA*

**Nicole Seiberlich**  
*Cleveland, OH, USA*

**A. Dean Sherry**  
*Dallas, TX, USA*

**Stefan Skare**  
*Stockholm, Sweden*

**Daniel K. Sodickson**  
*New York, NY, USA*

**Greg J. Stanisz**  
*Toronto, Ontario, Canada*

**Matthias Stuber**  
*Lausanne, Switzerland*

**Lawrence L. Wald**  
*Cambridge, MA, USA*

**Ed X. Wu**  
*Hong Kong, China*

**Dmitriy A. Yablonskiy**  
*St. Louis, MO, USA*

**Xiaohong Joe Zhou**  
*Chicago, IL, USA*

MANAGING EDITOR

Shannon Stepanian

*Magnetic Resonance in Medicine*, Editorial Office

EDITORIAL ASSISTANTS

Brandi Conroy, Anne Garber

*Magnetic Resonance in Medicine*, Editorial Office

**Copyright and Copying:** © 2018 International Society for Magnetic Resonance in Medicine. All rights reserved. No part of this publication may be reproduced, stored or transmitted in any form or by any means without the prior permission in writing from the copyright holder. Authorization to copy items for internal and personal use is granted by the copyright holder for libraries and other users registered with their local Reproduction Rights Organisation (RRO), e.g. Copyright Clearance Center (CCC), 222 Rosewood Drive, Danvers, MA 01923, USA ([www.copyright.com](http://www.copyright.com)), provided the appropriate fee is paid directly to the RRO. This consent does not extend to other kinds of copying such as copying for general distribution, for republication, for advertising or promotional purposes, for creating new collective works or for resale. Permissions for such reuse can be obtained using the RightsLink "Request Permissions" link on Wiley Online Library. Special requests should be addressed to: [permissions@wiley.com](mailto:permissions@wiley.com). Printed in the USA by Sheridan Printers.

**Magnetic Resonance in Medicine**, an official journal of the International Society for Magnetic Resonance in Medicine, (Print ISSN 0740-3194; Online ISSN 1522-2594 at Wiley Online Library, [wileyonlinelibrary.com/journal/mrm](http://wileyonlinelibrary.com/journal/mrm)) is published monthly on behalf of the International Society of Magnetic Resonance in Medicine by Wiley Subscription Services, Inc., a Wiley Company, 111 River St, Hoboken, NJ 07030-5774, email: [mrm@wiley.com](mailto:mrm@wiley.com). Periodicals postage paid at Hoboken, NJ, and additional offices. POSTMASTER: Send all address changes to *Magnetic Resonance in Medicine*, John Wiley & Sons Inc., c/o The Sheridan Press, PO Box 465, Hanover, PA 17331. The Publisher, the International Society for Magnetic Resonance in Medicine and Editors cannot be held responsible for errors or any consequences arising from the use of information contained in this journal: the views and opinions expressed do not necessarily reflect those of the Publisher, the International Society for Magnetic Resonance in Medicine and Editors, neither does the publication of advertisements constitute any endorsement by the Publisher, the International Society for Magnetic Resonance in Medicine and Editors of the products advertised.

**Back issues:** Single issues from current and prior year volumes are available at the current single issue price from [cs-journals@wiley.com](http://cs-journals@wiley.com). Earlier issues may be obtained from Periodicals Service Company, 351 Fairview Avenue—Ste 300, Hudson, NY 12534, USA. Tel: (+1) (518) 822-9300, Fax: (+1) (518) 822-9305, Email: [psc@periodicals.com](mailto:psc@periodicals.com)

**Delivery Terms and Legal Title:** Where the subscription price includes print issues and delivery is to the recipient's address, delivery terms are Delivered at Place (DAP); the recipient is responsible for paying any import duty or taxes. Title to all issues transfers FOB our shipping point, freight prepaid. We will endeavor to fulfill claims for missing or damaged copies within six months of publication, within our reasonable discretion and subject to availability. **Send subscription inquiries in care of John Wiley & Sons, Inc., Attn: Journals Admin, Dept. UK, 111 River Street, Hoboken, NJ 07030. Production Editor:** Rich Nagurka (email: [mrm@wiley.com](mailto:mrm@wiley.com)). **Information for subscribers:** *Magnetic Resonance in Medicine* is published in 12 issues per year. Institutional subscription prices for 2018 are: Print & Online: US\$4825 (US), US\$5200 (Rest of World), €3360 (Europe), £2657 (UK). Prices are exclusive of tax. Asia-Pacific GST, Canadian GST and European VAT will be applied at the appropriate rates. For more information on current tax rates, please go to [www.wileyonlinelibrary.com/tax-vat](http://www.wileyonlinelibrary.com/tax-vat). The price includes online access to the current and all online back files to January 1st 2014, where available. For other pricing options, including access information and terms and conditions, please visit [www.wileyonlinelibrary.com/access](http://wileyonlinelibrary.com/access). For submission instructions, subscription, and all other information visit: [wileyonlinelibrary.com/journal/mrm](http://wileyonlinelibrary.com/journal/mrm). *Magnetic Resonance in Medicine* accepts articles for Open Access publication. Please visit <http://olablab.wiley.com/WileyCDA/Section/id-828081.html> for further information about OnlineOpen. **Journal Customer Services:** For ordering information, claims and any enquiry concerning your journal subscription please go to [www.wiley.com/journals](http://www.wiley.com/journals) or contact your nearest office. **Americas:** Email: [cs-journals@wiley.com](mailto:cs-journals@wiley.com); Tel: (+1) (781) 388 8598 or (+1) (800) 835 6770 (toll free in the USA & Canada). **Europe, Middle East and Africa:** Email: [cs-journals@wiley.com](mailto:cs-journals@wiley.com); Tel: (+44) (0) 1865 778315. **Asia Pacific:** Email: [cs-journals@wiley.com](mailto:cs-journals@wiley.com); Tel: (+65) 6511 8000. **Japan:** For Japanese speaking support, Email: [cs-japan@wiley.com](mailto:cs-japan@wiley.com). **Visit our Online Customer Help** available in 7 languages at [www.wiley.com/go/help](http://www.wiley.com/go/help). **Change of Address:** Please forward to the subscriptions address listed above 6 weeks prior to move. Please enclose a copy of the mailing label or cite your subscription reference number in order to expedite handling. Missing copies will be supplied when losses have been sustained in transit and where reserve stock permits. Send claims in care of John Wiley & Sons, Inc., Attn: Journals Admin, Dept. UK, 111 River Street, Hoboken, NJ 07030. **Cancellations:** Subscription cancellations will not be accepted after the first issue has been mailed.

Wiley is a founding member of the UN-backed HINARI, AGORA, and OARE initiatives. They are now collectively known as Research4Life, making online scientific content available free or at a nominal cost to researchers in developing countries. Please visit Wiley's Content Access Corporate Citizenship site: <http://www.wiley.com/WileyCDA/Section/id-390082.html>

View this journal online at [wileyonlinelibrary.com/journal/mrm](http://wileyonlinelibrary.com/journal/mrm)

Wiley's Corporate Citizenship initiative seeks to address the environmental, social, economic, and ethical challenges faced in our business and which are important to our diverse stakeholder groups. Since launching the initiative, we have focused on sharing our content with those in need, enhancing community philanthropy, reducing our carbon impact, creating global guidelines and best practices for paper use, establishing a vendor code of ethics, and engaging our colleagues and other stakeholders in our efforts. Follow our progress at [www.wiley.com/go/citizenship](http://www.wiley.com/go/citizenship).

**The journal is indexed by:** Index Medicus/MEDLINE/PubMed • Current Contents/Clinical Medicine • Current Concepts/Life Sciences • Science Citation Index • Science Citation Index Expanded • EMBASE/Excerpta Medica • Current Advances in Cancer Research • Biomedical Engineering Citation Index • Research Alert • INSPEC • Reference Update • SCOPUS • Cambridge Scientific Abstracts • Chemical Abstracts Service/SciFinder • SIIC Databases (Sociedad Iberoamericana de Informacion Cientifica)

This journal is printed on acid-free paper.