# Physics-Uspekhi

Advances in Physical Sciences



November 2014 Volume 57, Number 11

Translation of the Russian journal

Успехи физических наук, Uspekhi Fizicheskikh Nauk

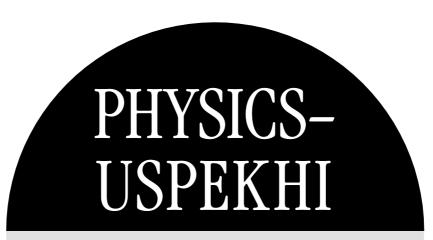
November 2014, Volume 184, No. 11



Turpion

IOP Publishing





ISSN 1063-7869 (Print) ISSN 1468-4780 (Online)

CODEN: PHUSEY

### Uspekhi Fizicheskikh Nauk

**Editor** 

LV Keldysh PNLebedev Physical Institute,

Russian Academy of Sciences (RAS), Moscow

First Deputy Editor

VA Rubakov Institute for Nuclear Research, RAS, Moscow

Associate Editors

L P Pitaevskii PL Kapitza Institute for Physical Problems,

RAS, Moscow

MV Lomonosov Moscow State University, OV Rudenko

Moscow

**Managing Editor** M S Aksent'eva Uspekhi Fizicheskikh Nauk, RAS, Moscow

**Editorial Board** 

E B Aleksandrov All-Russian Research Center

'SI Vavilov State Optical Institute'

PI Arseev PNLebedev Physical Institute, RAS, Moscow VS Beskin PNLebedev Physical Institute, RAS, Moscow V B Braginsky MV Lomonosov Moscow State University,

Moscow

YuVGulyaev Institute of Radioengineering and Electronics,

RAS, Moscow

Russian State Research Center **SPD**enisov

Institute for High Energy Physics'

I M Dremin PNLebedev Physical Institute, RAS, Moscow GR Ivanitskii Institute of Theoretical and Experimental

Biology, RAS, Pushchino, Moscow Region A A Kaplyanskii

A F Ioffe Physico-Technical Institute,

RAS, St.-Petersburg

GI Budker Institute of Nuclear Physics, GN Kulipanov

RAS, Novosibirsk

PNLebedev Physical Institute, RAS, Moscow M B Mensky GA Mesyats PNLebedev Physical Institute, RAS, Moscow

L B Okun Russian State Research Center

Institute of Theoretical and Experimental

Physics', Moscow

V I Ritus PNLebedev Physical Institute, RAS, Moscow M V Sadovskii

Institute of Electrophysics, Ural Branch of RAS,

Ekaterinburg

Institute for High Temperatures, RAS, Moscow **BM** Smirnov

Institute for High Energy Density, V E Fortov

RAS, Moscow

### Scientific and Staff Editors

MS Aksent'eva, EA Frimer, TB Larionova, TG Orekhova, TP Romanova, EV Zakharova

Uspekhi Fizicheskikh Nauk (Успехи Физических Наук, www.ufn.ru) publishes reviews of the current state of the most topical problems in physics and in associated fields under the general headings: reviews of topical problems, physics of our days, instruments and methods of investigation, methodological notes, from the history of physics, conferences and symposia, personalia, physics news on the Internet, and bibliography. The journal was founded in 1918 and is published monthly.

© 2014 Uspekhi Fizicheskikh Nauk and PN Lebedev Physical Institute of the Russian Academy of Sciences

## Physics - Uspekhi

**Scientific Editors** 

MS Aksent'eva, A Radzig, AM Semikhatov

**English Language Editor** 

K Franchuk, M.A., Carleton University, Ottawa, Canada

**Desk Editors** 

AV Bobkov, NV Gribkova, OV Morgunova

Physics-Uspekhi (Advances in Physical Sciences) is the English edition of the Russian monthly journal Uspekhi Fizicheskikh Nauk. Translation into English started with Russian volume 66. From 1958 until 1992 the journal was published by American Institute of Physics under the title Soviet Physics - Uspekhi and in 1993 under its current title Physics - Uspekhi. Since 1994 Physics - Uspekhi has been published jointly by Uspekhi Fizicheskikh Nauk and Turpion Ltd. From the beginning of 1996 *Physics – Uspekhi* is being translated, typeset and edited in Moscow by Uspekhi Fizicheskikh Nauk (UFN). From 2009 published by Uspekhi Fizicheskikh Nauk, Moscow Printed by Page Bros, Norwich, UK.

Institutional subscription information (volume 57, 2014, monthly) For all countries, except the United States, Canada, Central and South America, the subscription rates are: Print + Online (1958 2014) £ 1786; Online only (1958 – 2014) £ 1607; Single issue £ 179. Delivery is by air-speeded mail from the UK.

Orders, back issues, change of address to: Physics-Uspekhi, Journals Subscription Fulfilment, IOP Publishing, Temple Circus, Temple Way, Bristol BS16HG, United Kingdom

For the United States, Canada, Central and South America, the subscription rates are:

Print + Online (1958 – 2014) US \$3215; Online only (1958 – 2014) US \$ 2894; Single issue US \$ 322. Delivery is by transatlantic airfreight and onward mailing. United States Postal Identification Statement Physics – Uspekhi, volume 57, published monthly. Periodicals Postage Paid at Continental Station, PA and additional mailing offices. POSTMASTER: Send orders, address changes to Physics - Uspekhi, IOP Publishing, PO Box 320, Congers, NY 10920-0320, USA.

Online services: Since 2008 electronic access to the journal content is hosted by IOP Publishing. All subscriptions to the journal include electronic access dating from the first English translation volume. The electronic version of the journal is available at http:// iopscience.org/phu. All questions regarding online access should be sent to customer services at custserv@iop.org or custserv@turpion.ru

All rights reserved. No part of this publication may be reproduced, stored in a retrieval system, or transmitted in any form, or by any means, electronic, mechanical, photographic, recording, or otherwise, without the prior permission of Uspekhi Fizicheskikh Nauk.

Editorial Office: P N Lebedev Physical Institute, RAS, Leninskii prospekt 53,119991 Moscow, Russian Federation Tel. (7-499) 132 62 65, (7-499) 132 63 48, (7-499) 190 34 52 Tel./Fax (7-499) 190 42 44. É-mail: ufn@ufn.ru

© 2014 Uspekhi Fizicheskikh Nauk and PN Lebedev Physical Institute of the Russian Academy of Sciences

Russian original reference Usp. Fiz. Nauk Vol. <b>184</b> , pages	Contents	English translation reference Phys. Usp. Vol. 57, pages
1153	Electrical cycle in the Earth's atmosphere B M Smirnov	1041
1177	PT-symmetry in optics A A Zyablovsky, A P Vinogradov, A A Pukhov, A V Dorofeenko, A A Lisyansky	1063
1199	Water dimer and the atmospheric continuum M Yu Tretyakov, M A Koshelev, E A Serov, V V Parshin, T A Odintsova, G M Bubnov	1083
1217	X-ray crystal interferometers V V Lider	1099
1237	Hybrid systems for transuranic waste transmutation in nuclear power reactors: state of the art and future prospects D V Yurov, V V Prikhod'ko	1118
1249	Simple lecture demonstrations of instability and self-organization V V Mayer, E I Varaksina, V A Saranin	1130
1255	On the multiple internal reflections of particles and photons tunneling in one, two, or three dimensions V S Olkhovsky	1136
1216	Physics news on the Internet Yu N Eroshenko	1146

 $\Diamond$ 

# In the next issue

Laser ion acceleration for hadron therapy

S V Bulanov, J J Wilkens, T Zh Esirkepov, G Korn, G Kraft, S D Kraft, M Molls, V S Khoroshkov

Anisotropic interactions in magnetic crystals with S-state ions. Nanostructures S G Ovchinnikov, V V Rudenko

Review of scientific topics for Millimetron space observatory N S Kardashev et al.

Jubilee session of the FIAN and IOFAN Research Councils marking 300 years from the beginning of physics research in Russia and 80 years of FIAN (28 April 2014)

Precision laser spectroscopy in fundamental studies

N N Kolachevsky, K Yu Khabarova

Conferences and symposia

Physics news on the Internet

Personalia

Errata and amendments

Authors index to Vol. 57, 2014

Subject index to Vol. 57, 2014

Concordance table of page numbers of papers in the English and Russian editions



063-7869(2014)57:11;1-U