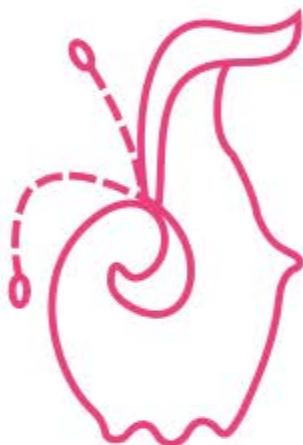


REVISTA MEXICANA DE FÍSICA

PUBLICACIÓN BIMESTRAL
DE LA SOCIEDAD
MEXICANA DE FÍSICA



<http://rmf.smf.mx>

ISSN 0035-00IX
e-ISSN 2683-2224

VOLUME 66
ISSUE 1
JANUARY-FEBRUARY
2020

Chief Editor:

Alejandro Ayala

Instituto de Ciencias Nucleares, UNAM, México

Editorial Board**Atomic and Molecular Physics:**

Rocío Jáuregui

Instituto de Física, UNAM, México

Condensed Matter:

Alejandro Gil-Villegas Montiel

DCI-Campus León, Universidad de Guanajuato, México

Enrique Muñoz Tavera

Departamento de Física, Pontificia Universidad Católica de Chile, Chile

Fluid Dynamics:

Máximo Pliego Díaz

Instituto Tecnológico de Querétaro, México

Sergio Cuevas García

Instituto de Energías Renovables, UNAM, México

Gravitation, Mathematical Physics and Field Theory:

Luis Fernando Urrutia

Instituto de Ciencias Nucleares, UNAM, México

High Energy Physics:

María Elena Tejeda-Yeomans

Universidad de Colima, Facultad de Ciencias-CUICBAS, México

Instrumentation:

Luis Manuel Montaño

Departamento de Física, Cinvestav-CDMX

Mario Rodríguez Cahuantzi

Facultad de Ciencias Físico Matemáticas de la BUAP

Material Sciences:

José Gerardo Cabañas Moreno

Programa de Ciencias y Nanotecnología, Cinvestav-México

Medical Physics:

Mercedes Rodríguez

Instituto de Física, UNAM, México

Nuclear Physics:

Ivano Lombardo

INFN - Sezione di Catania, Italy

Larry McLerran

Institute for Nuclear Theory, University of Washington, Seattle, USA

Norberto Scoccola

Comisión Nacional de Energía Atómica, Argentina

Optics:

Héctor Manuel Moya Cessa

Instituto Nacional de Astrofísica, Óptica y Electrónica, México

Carlos Treviño

Instituto Nacional de Astrofísica, Óptica y Electrónica, México

Plasma Physics:

Julio Herrera

Instituto de Ciencias Nucleares, UNAM, México.

Solid State Physics:

Oracio Navarro

Instituto de Investigaciones en Materiales, UNAM, Campus Morelia, México.

Thermodynamics and Statistical Physics:

Héctor Dominguez

Instituto de Investigaciones en Materiales, UNAM, México

Secretary:

María Magdalena López Reynoso

Sociedad Mexicana de Física

Technical Staff:

Efraín R. Garrido Román

Sociedad Mexicana de Física

Víctor Maya Higuera

Sociedad Mexicana de Física

Copyeditors:

Luz Gabriela Barrientos Mariscal,

Jordi Salinas San Martín,

REVISTA MEXICANA DE FÍSICA, year 66, issue 1, January-February 2020. Bimonthly Journal published by Sociedad Mexicana de Física, A.C. Departamento de Física, 2º Piso, Facultad de Ciencias, Universidad Nacional Autónoma de México, Ciudad Universitaria, Alcaldía Coyacán, C.P. 04510 , Ciudad de México. Apartado Postal 70-348. Tel. (+52 55)5622-4946, <https://www.smf.mx/>, <https://rmf.smf.mx/ojs/>, rmf@ciencias.unam.mx. Responsible Editor: José Alejandro Ayala Mercado. Copy Rights exclusive use of the title No. 04-2013-070116484400-102, ISSN: 0035-001X, both granted by Instituto Nacional del Derecho de Autor. Legal Titled No. 3110, Legal Content No. 2775, granted by Comisión Calificadora de Publicaciones y Revistas Ilustradas of Secretaría de Gobernación. SEPOMEX permit, in process. Printed by Reproducciones Gráficas del Sur, S.A. de C.V., Amatl No. 20, Col. Santo Domingo, Alcaldía Coyoacán, C.P. 04369, Ciudad de México, Tel.: 5619-4088. This issue was printed on December 31, 2019 with a print run of 150 copies.

Revista Mexicana de Física is published with the sponsorship of: Consejo Nacional de Ciencia y Tecnología, and Universidad Nacional Autónoma de México through Rectoría, Facultad de Ciencias, Instituto de Astronomía, Instituto de Ciencias Nucleares, Instituto de Investigaciones en Materiales e Instituto de Física.

Indexed in: Actualidad Iberoamericana, Astron. & Astrophys. Abstr., Bull. Signal., Chem. Abstr., Curr. Cont., Curr. Math. Pub., Curr. Pap. Phys., Electr. & Electron. Abstr., INIS Atomind., Journal Citation Reports (JCR), Math. Sci., LatIndex, Math. Rev., Nucl. Sci. Abstr., PERIODICA, Phys. Abstr., Phys. Ber., Res. Alert, Sci. Abstr., Sci. Cit. Ind., SciSearch y SciELO Cit. Ind. Included in the Revistas Mexicanas de Investigación Científica y Tecnológica del Consejo Nacional de Ciencia y Tecnología (CONACyT).

Instructions for authors are published in <https://rmf.smf.mx/ojs/rmf/about/submissions#authorGuidelines>. The cost of the annual subscription is of \$1300.00 MXN for subscribers within Mexico, \$230 USD for Central and North America and \$235 USD for the rest of world. Price of each individual copy is \$170.00 MXN.

The partial or total reproduction of its contents is authorized citing the source: Revista Mexicana de Física or Rev. Mex. Fis. Signed articles are the responsibility of the authors.

Cover design: Arte Gráfico, Sur 71 No. 501, Col. Justo Sierra, 09460, Ciudad de México.

REVISTA MEXICANA DE FÍSICA

VOLUME 66
ISSUE 1
JANUARY-
FEBRUARY
2020

CONTENTS

□ Research

Atomic and Molecular Physics

- Relativistic treatment of the Hellmann-generalized Morse potential,
P. O. OKOI, C. O. EDET AND T. O. MAGU

1–13

Condensed Matter

- Anisotropic CuInSe₂ nanocrystals: synthesis, optical properties and their effect
on photoelectric response of dye-sensitized solar cell,

A.I. ABDEL-SALAM, M. MOHSEN ABDELAZIZ, A.N. EMAM,
A.S. MANSOUR, A.A.F. ZIKRY, M.B. MOHAMED
AND Y.H. ELBASHAR

14–22

- Complementary atomic force microscopy and magnetic force microscopy study for
the magnetic transition of cobalt clusters onto gold substrates,

M. RIVERA, F. I. MARTINEZ-VADO, L.H. MENDOZA-HUIZAR,
AND I. BETANCOURT

23–29

- Synthesis and crystal structure determination of the new olivine-type
compound Mn₂Sn-Se₄,

C. CHACÓN, P. DELGADO-NIÑO, AND G. E. DELGADO

30–34

- A theoretical study of variation of photoionization cross section of donor impurities
in a GaAs quantum dot of cylindrical geometry with incident photon frequency, donor
location along the dot axis and applied uniaxial stress,

F. OKETCH AND H. OYOKO

35–41

- Magnetic relaxation in (Bi, Pb)-2223 superconducting ceramics doped with
α-Al₂O₃ nanoparticles,

M. HERNÁNDEZ-WOLPEZ, L. C. GUTIÉRREZ-RIVERO, I. GARCÍA-FORNARIS,
E. GOVEA-ALCAIDE, F. ABUD, R. F. JARDIM, AND P. MUNÉ

42–46

continued

continued

contents

Rev. Mex. Fis. **66** (1) (2020)

JANUARY-
FEBRUARY
2020

A comparative study between the addition of nano and micro-particles of Co_3O_4 on the electrical and microstructural properties of a ceramic system based on SnO_2 ,

M.I. MIRANDA-LÓPEZ, M.B. HERNÁNDEZ, B.S. VERA-BARRIOS,
A. TOQUI-TERAN, AND J.A. AGUILAR-MARTÍNEZ

47–55

Fluid Dynamics

Modelado computacional Reynolds-Averaged Navier-Stokes flamelets para el estudio del proceso de combustión turbulenta de sprays,

G. GUEVARA-MORALES, O. HUERTA-CHÁVEZ, AND A. ARIAS-MONTAÑO
Experimental and numerical study of submerged jets from pipes of different wall thicknesses for $Re < 1$,

M. SÁNCHEZ-ROSAS, J. CASILLAS-NAVARRETE, J. A. JIMENEZ-BERNAL,
V. N. KURDYUMOV, AND A. MEDINA

56–68

69–76

Gravitation, Mathematical Physics and Field Theory

Massless fermions localization on domain walls,
R. GUERRERO, R.O. RODRIGUEZ, AND F. CARRERAS

77–81

Nuclear Physics

Single particle spectrum of a nucleon in the harmonic oscillator mean field with spin-orbit coupling - a semiclassical view,

R. GUPTA AND S. SUNDER MALIK

82–90

Other Areas in Physics

Sensing system with an artificial neural network based on floating-gate metal oxide semiconductor transistors,

J.L. GONZÁLEZ VIDAL, M.A. REYES-BARRANCA, E.N. VÁZQUEZ-ACOSTA,
AND J.J. RAYGOZA PANDURO

91–97

continued

continued

contents

Rev. Mex. Fis. **66** (1) (2020)

JANUARY-
FEBRUARY
2020

Trajectory tracking error using fractional order time-delay recurrent neural networks using Krasovskii-Lur'e functional for Chua's circuit via inverse optimal control

J. PÉREZ PADRÓN, J.P. PÉREZ PADRÓN, C.F. MENDEZ-BARRIOS
AND E.J. GONZÁLEZ-GALVÁN

98–104

Solid State Physics

Nanotubes and other allotropic carbon forms by chemical vapor deposition on an inconel surface,

F. PÉREZ-BUSTAMANTE, F. AVALOS-BELMONTE, J. RAMOS-CANO,
AND R. PÉREZ-BUSTAMANTE

105–109

Thermodynamics and statiscal Physics

Thermal properties of three-dimensional Morse potential for some diatomic molecules via Euler-Maclaurin approximation,

K. CHABI AND A. BOUMALI

110–120