**El-Wakil DEC 2012**

**Time-fractional study of electron acoustic solitary waves in plasma of cold electron and two isothermal ions**

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**Abstract:**
In this paper, a homogeneous system of unmagnetized collisionless plasma consisting of a cold electron fluid, low-temperature ion obeying Boltzmann-type distribution and high-temperature ion obeying non-thermal distribution is considered. The perturbation method with two different forms of stretching will be considered to drive the KdV and modified KdV (mKdV) equations. The Agrawal's method is applied to formulate the time-fractional KdV and mKdV equations. A variational iteration method is used to solve these equations. The results show that the fractional order of the differential equations can be used to modify the shape of the solitary pulse instead of adding higher order dissipation terms to the equations. This study may be useful to construct the compressive and rarefactive electrostatic potential pulses associated with the broadband electrostatic noise type emissions.

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Ion-acoustic waves in unmagnetized collisionless weakly relativistic plasma of warm-ion and isothermal-electron using time-fractional KdV equation
Author(s): El-Wakil, SA (El-Wakil, Sayed A.)[ 1 ]; Abulwafa, EM (Abulwafa, Essam M.)[ 1 ]; El-Shewy, EK (El-Shewy, Emad K.)[ 1 ]; Mahmoud, AA (Mahmoud, Abeer A.)[ 1 ]
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Abstract:
Collisionless unmagnetized plasma consisting of a mixture of warm ion-fluid and isothermal-electron is considered, assuming that the ion flow velocity has a weak relativistic effect. The reductive perturbation method has been employed to derive the Korteweg-de Vries (KdV) equation for small - but finite-amplitude electrostatic ion-acoustic waves in this plasma. The semi-inverse method and Agrawal's method lead to the Euler-Lagrange equation that leads to the time fractional KdV equation. The variational-iteration method given by He is used to solve the derived time fractional KdV equation. The calculations show that the fractional order may play the same rule of higher order dissipation in KdV equation to modulate the soliton wave amplitude in the plasma system. The results of the present investigation may be applicable to some plasma environments, such as space-plasmas, laser-plasma interaction, plasma sheet boundary layer of the earth's magnetosphere, solar atmosphere and interplanetary space. (C) 2012 COSPA R. Published by Elsevier Ltd. All rights reserved.
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Author(s): Podlubny, I.
Source: <IT>Fractional Differential Equations</IT> Published: 1999
Publisher: Academic Press, New York

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Author(s): Sabatier, J.; Agrawal, O. P.; Tenreiro Machado, J. A.
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Author(s): Sanchez, R.; Carreras, B. A.; Newman, D. E.; et al.
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Author(s): Vette, J.I.
Book Editor(s): McCormac, B.M.
Conference: Particles and fields in the magnetosphere Location: Santa Barbara, CA, USADate: 4-15 Aug. 1969 Sponsor(s): Army Research Office; Defence Atomic Support Agency; Lockheed Palo Alto Research Laboratory; Office of Naval Research; University of California, Berkeley, Space Science Laboratory; University of California, San Diego, Department of Applied Electrophysics
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Author(s): WASHIMI, H; TANIUTI, T
Source: PHYSICAL REVIEW LETTERS Volume: 17 Issue: 19 Pages: 996-& DOI: 10.1103/PhysRevLett.17.996 Abstract Number: A1967-04244 Published: 1966

**El-Wakil, SA SEP 2011**

**Time-fractional KdV equation for plasma of two different temperature electrons and stationary ion**

Author(s): El-Wakil, SA (El-Wakil, S. A.)[1]; Abulwafa, EM (Abulwafa, Essam M.)[1]; El-Shewy, EK (El-Shewy, E. K.)[1]; Mahmoud, AA (Mahmoud, Abeer A.)[1]

Source: PHYSICS OF PLASMAS Volume: 18 Issue: 9 Article Number: 092116 DOI: 10.1063/1.3640533 Published: SEP 2011

**Abstract:**

Using the time-fractional KdV equation, the nonlinear properties of small but finite amplitude electron-acoustic solitary waves are studied in a homogeneous system of unmagnetized collisionless plasma. This plasma consists of cold electrons fluid, non-thermal hot electrons, and stationary ions. Employing the reductive perturbation technique and the Euler-Lagrange equation, the time-fractional KdV equation is derived and it is solved using variational method. It is found that the time-fractional parameter significantly changes the soliton amplitude of the electron-acoustic solitary waves. The results are compared with the structures of the broadband electrostatic noise observed in the dayside auroral zone. (C) 2011 American Institute of Physics. [doi:10.1063/1.3640533]

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**KeyWords** Plus: ACOUSTIC SOLITARY WAVES; BAND ELECTROSTATIC NOISE; DOUBLE-LAYERS; VARIATIONAL-PRINCIPLES; PROPAGATION; GENERATION; AMPLITUDE; SOLITONS

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Research Areas: Physics

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Author(s): Agrawal, OP
Source: JOURNAL OF MATHEMATICAL ANALYSIS AND APPLICATIONS Volume: 272 Issue: 1 Pages: 368-379 Article Number: PII S0022-247X(02)00180-4 DOI: 10.1016/S0022-247X(02)00180-4 Abstract Number: A2003-01-0230-015 Published: AUG 1 2002

2. Title: Fractional variational calculus in terms of Riesz fractional derivatives Author(s): Agrawal, O. P.
Source: JOURNAL OF PHYSICS A-MATHEMATICAL AND THEORETICAL Volume: 40 Issue: 24 Pages: 6287-6303 DOI: 10.1088/1751-8113/40/24/003 Published: JUN 15 2007

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Editor(s): Baleanu, D.; Guvenc, Z. B.; Tenreiro Machado, J. A.

Source: New Trends in Nanotechnology and Fractional Calculus Applications Published: 2010
Publisher: Springer

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Author(s): Baleanu, Dumitru; Machado, J. A. Tenreiro
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Author(s): BOSTROM, R; GUSTAFSSON, G; HOLBACK, B; et al.
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Author(s): Bounds, SR; Pfaff, RF; Knowlton, SF; et al.
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Author(s): CAIRNS, RA; MAMUM, AA; BINGHAM, R; et al.
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Author(s): DUBOULOZ, N; POTTELETTE, R; MALINGRE, M; et al.
Source: GEOPHYSICAL RESEARCH LETTERS Volume: 18 Issue: 2 Pages: 155-158 DOI: 10.1029/90GL02677 Abstract Number: A1991-105373 Published: FEB 1991

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Author(s): DUBOULOZ, N; POTTELETTE, R; MALINGRE, M; et al.
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Author(s): El-Shewy, E. K.
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Author(s): El-Shewy, EK
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Author(s): El-Wakil, S. A.; Abulwafa, E. M.; Zahran, M. A.; et al.

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Author(s): Gustafson, K.; del-Castillo-Negrete, D.; Dorland, W.
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Author(s): He, JH
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Author(s): He, J.H.
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Author(s): HENRY, D; TREGUIER, JP
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Author(s): Mamun, AA; Shukla, PK
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Author(s): Momani, Shaher; Odibat, Zaid; Alawneh, Ahmed
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Author(s): Mozer, FS; Ergun, R; Temerin, M; et al.
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Author(s): Pottelette, R; Ergun, RE; Treumann, RA; et al.

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Author(s): Sabatier, J.; Agrawal, O. P.; Tenreiro Machado, J. A.
Source: ADV FRACTIONAL CALCU Published: 2007
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Author(s): Sahu, Biswajit
Source: PHYSICS OF PLASMAS Volume: 17 Issue: 12 Article Number: 122305 DOI: 10.1063/1.3527988 Published: DEC 2010

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Author(s): Sahu, B; Roychoudhury, R
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Author(s): Sanchez, R.; Carreras, B. A.; Newman, D. E.; et al.
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Author(s): Singh, SV; Reddy, RV; Lakhina, GS
Book Editor(s): Malingre, M
Conference: D3 2 Symposium of COSPAR Scientific Commission D held at the 33rd COSPAR Scientific Assembly Location: WARSAW, POLANDDate: JUL, 2000
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Author(s): Singh, SV; Lakhina, GS
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Author(s): Singh, SV; Lakhina, GS
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Author(s): TEMERIN, M; CERNY, K; LOTKO, W; et al.
Source: PHYSICAL REVIEW LETTERS Volume: 48 Issue: 17 Pages: 1175-1179 DOI: 10.1103/PhysRevLett.48.1175 Abstract Number: A1982-071191 Published: 1982

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Author(s): Tribeche, Mouloud; Djebarni, Lyes
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Author(s): WASHIMI, H; TANIUTI, T
Source: PHYSICAL REVIEW LETTERS Volume: 17 Issue: 19 Pages: 996-& DOI: 10.1103/PhysRevLett.17.996 Abstract Number: A1967-04244 Published: 1966

**El-Wakil,SA JUL 2011**

**Time-fractional KdV equation: formulation and solution using variational methods**

Author(s): El-Wakil, SA (El-Wakil, S. A.)[1]; Abulwafa, EM (Abulwafa, E. M.)[1]; Zahran, MA (Zahran, M. A.)[1]; Mahmoud, AA (Mahmoud, A. A.)[1]

Source: NONLINEAR DYNAMICS Volume: 65 Issue: 1-2 Pages: 55-63 DOI: 10.1007/s11071-010-9873-5 Published: JUL 2011

**Abstract:**
In this work, the semi-inverse method has been used to derive the Lagrangian of the Korteweg-de Vries (KdV) equation. Then the time operator of the Lagrangian of the KdV equation has been transformed into fractional domain in terms of the left-Riemann-Liouville fractional differential operator. The variational of the functional of this Lagrangian leads neatly to Euler-Lagrange equation. Via Agrawal's method, one can easily derive the time-fractional KdV equation from this Euler-Lagrange equation. Remarkably, the time-fractional term in the resulting KdV equation is obtained in Riesz fractional derivative in a direct manner. As a second step, the derived time-fractional KdV equation is solved using He's variational-iteration method. The calculations are carried out using initial condition depends on the nonlinear and dispersion coefficients of the KdV equation. We remark that more pronounced effects and deeper insight into the formation and properties of the resulting solitary wave by additionally considering the fractional order derivative beside the nonlinearity and dispersion terms.

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Document Type: Article

Language: English

Author Keywords: Riemann-Liouville fractional differential operator; Euler-Lagrange equation; Riesz fractional derivative; Fractional KdV equation; He's variational-iteration method; Solitary wave

**KeyWords** Plus: DIFFERENTIAL-EQUATIONS; CLASSICAL FIELDS; DERIVATIVES; CALCULUS; PRINCIPLES; MECHANICS; EXISTENCE; MEDIA; ORDER

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Publisher: SPRINGER, VAN GODEWIJCKSTRAAT 30, 3311 GZ DORDRECHT, NETHERLANDS

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Author(s): Agrawal, OP
Source: JOURNAL OF MATHEMATICAL ANALYSIS AND APPLICATIONS Volume: 272 Issue: 1 Pages: 368-379 Article Number: PII S0022-247X(02)00180-4 DOI: 10.1016/S0022-247X(02)00180-4 Abstract Number: A2003-01-0230-015 Published: AUG 1 2002

2. Title: Fractional variational calculus and the transversality conditions
Author(s): Agrawal, O. P.
Source: JOURNAL OF PHYSICS A-MATHEMATICAL AND GENERAL Volume: 39 Issue: 33 Pages: 10375-10384 DOI: 10.1088/0305-4470/39/33/008 Published: AUG 18 2006

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Author(s): Agrawal, O. P.
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Author(s): AGRAWAL OP
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Author(s): Agrawal, OP
Source: NONLINEAR DYNAMICS Volume: 38 Issue: 1-4 Pages: 323-337 DOI: 10.1007/s11071-004-3764-6 Abstract Number: A2005-14-0230-031; C2005-07-1330-062 Published: DEC 2004

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Author(s): Attari, Mina; Haeri, Mohammad; Tavazoei, Mohammad Saleh
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Author(s): Babakhani, A; Daftardar-Gejji, V
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Author(s): Baleanu, Dumitru; Trujillo, Juan I.
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Author(s): Baleanu, D; Avkar, T
Source: NUOVO CIMENTO DELLA SOCIETA ITALIANA DI FISICA B-GENERAL PHYSICS RELATIVITY ASTRONOMY AND MATHEMATICAL PHYSICS AND METHODS Volume: 119 Issue: 1 Pages: 73-79 DOI: 10.1393/ncb/i2003-10062-y Abstract Number: A2005-06-0230-018 Published: JAN 2004

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Author(s): BALEANU D
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Author(s): Baleanu, D; Muslih, SI
Source: PHYSICA SCRIPTA Volume: 72 Issue: 2-3 Pages: 119-121 DOI: 10.1238/Physica.Regular.072a00119 Published: AUG-SEP 2005

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Author(s): Bateman, H
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Author(s): Frederico, Gastao S. F.; Torres, Delfim F. M.
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Author(s): He, J.H.
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Author(s): He, JH
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Author(s): He, JH
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Author(s): He, JH
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Author(s): Herzallah, Mohamed A. E.; Baleanu, Dumitru
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Author(s): Heymans, N
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Author(s): Korteweg, DJ; de Vries, G.
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Author(s): LUCHKO, YF; SRIVASTAVA, HM
Source: COMPUTERS & MATHEMATICS WITH APPLICATIONS Volume: 29 Issue: 8 Pages: 73-85 DOI: 10.1016/0898-1221(95)00031-S Published: APR 1995

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Author(s): Tenreiro Machado, J. A.
Source: NONLINEAR DYNAMICS Volume: 57 Issue: 1-2 Pages: 253-260 DOI: 10.1007/s11071-008-9436-1 Published: JUL 2009

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Author(s): Vilela Mendes, R.
Source: NONLINEAR DYNAMICS Volume: 55 Issue: 4 Pages: 395-399 DOI: 10.1007/s11071-008-9372-0 Published: MAR 2009

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Author(s): Molliq, RY; Molliq, MSM; Noorani, MSM; et al.
Source: Nonlinear Anal RWA Volume: 10 Pages: 1854-69 Published: 2009

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Author(s): MOMANI S
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Author(s): Muslih, SI; Baleanu, D; Rabei, E
Source: PHYSICA SCRIPTA Volume: 73 Issue: 5 Pages: 436-438 DOI: 10.1088/0031-8949/73/5/003 Published: MAY 2006

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Author(s): Podlubny, I.

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Author(s): Rabei, Eqab M.; Altarazi, Ibrahim M. A.; Muslih, Sami I.; et al.
Source: NONLINEAR DYNAMICS Volume: 57 Issue: 1-2 Pages: 171-175 DOI: 10.1007/s11071-008-9430-7 Published: JUL 2009
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Author(s): Ray, SS; Bera, RK
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Author(s): Riewe, F
Source: PHYSICAL REVIEW E Volume: 53 Issue: 2 Pages: 1890-1899 DOI: 10.1103/PhysRevE.53.1890 Abstract Number: A1996-09-0320-006 Published: FEB 1996

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Author(s): Riewe, F
Source: PHYSICAL REVIEW E Volume: 55 Issue: 3 Pages: 3581-3592 DOI: 10.1103/PhysRevE.55.3581 Part: Part b Abstract Number: A1997-12-0320-004 Published: MAR 1997

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Author(s): Sabatier, J.; Agrawal, O. P.; Tenreiro Machado, J. A.
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Author(s): SAMKO SG
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Author(s): Tarasov, Vasily E.; Zaslavsky, George M.
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Author(s): Tarasov, VE; Zaslavsky, GM
Source: PHYSICA A-STATISTICAL MECHANICS AND ITS APPLICATIONS Volume: 354 Pages: 249-261 DOI: 10.1016/j.physa.2005.02.047 Published: AUG 15 2005

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Author(s): Tavazoei, Mohammad Saleh; Haeri, Mohammad
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Author(s): Zhang, SQ
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**El-Wakil,SA MAY 2011**

**Time-fractional KdV equation for electron-acoustic waves in plasma of cold electron and two different temperature isothermal ions**

Author(s): El-Wakil, SA (El-Wakil, Sayed A.)[1]; Abulwafa, EM (Abulwafa, Essam M.)[1]; El-shewy, EK (El-shewy, Emad K.)[1]; Mahmoud, AA (Mahmoud, Abeer A.)[1]

Source: ASTROPHYSICS AND SPACE SCIENCE Volume: 333 Issue: 1 Pages: 269-276 DOI: 10.1007/s10509-011-0629-6 Published: MAY 2011

**Abstract:**
The time fractional KdV equation is derived for small but finite amplitude electron-acoustic solitary waves in plasma of cold electron fluid with two different temperature isothermal ions. The effects of the time fractional parameter on the electrostatic solitary structures are presented. It is shown that the effect of time fractional parameter can be used to modify the amplitude of the electrostatic waves (viz. the amplitude, width and electric field) of the electron-acoustic solitary waves. The model may provide a possible explanation for the low-frequency component of the broadband electrostatic noise in the plasma sheet boundary layer of the Earth's magnetotail where the electron beams are not present.

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**KeyWords Plus:** SOLITARY WAVES; NONTHERMAL ELECTRONS; EARTHS MAGNETOTAIL; DERIVATIVES; MECHANICS; AMPLITUDE; SOLITONS

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Author(s): Tagare, SG; Singh, SV; Reddy, RV; et al.
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Author(s): Tarasov, Vasily E.; Zaslavsky, George M.
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Author(s): Tarasov, VE; Zaslavsky, GM
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Author(s): WASHIMI, H; TANIUTI, T
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Author(s): Wu, G.C.; He, J.H.
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Author(s): Younsi, Smain; Tribeche, Mouloud
Source: ASTROPHYSICS AND SPACE SCIENCE Volume: 330 Issue: 2 Pages: 295-300 DOI:
10.1007/s10509-010-0404-0 Published: DEC 2010

**El-Wakil,SA APR 2011**

**Ion-acoustic waves in plasma of warm ions and isothermal electrons using time-fractional KdV equation**

Author(s): El-Wakil, SA (El-Wakil, Sayed A.)[1]; Abulwafa, EM (Abulwafa, Essam M.)[1]; El-Shewy, EK (El-Shewy, Emad K.)[1]; Mahmoud, AA (Mahmoud, Abeer A.)[1]

Source: CHINESE PHYSICS B Volume: 20 Issue: 4 Article Number: 040508 DOI: 10.1088/1674-1056/20/4/040508 Published: APR 2011

**Abstract:** The ion-acoustic solitary wave in collisionless unmagnetized plasma consisting of warm ions-fluid and isothermal electrons is studied using the time fractional KdV equation. The reductive perturbation method has been employed to derive the Korteweg-de Vries equation for small but finite amplitude ion-acoustic wave in warm plasma. The Lagrangian of the time fractional KdV equation is used in a similar form to the Lagrangian of the regular KdV equation with fractional derivative for the time differentiation. The variation of the functional of this Lagrangian leads to the Euler-Lagrange equation that gives the time fractional KdV equation. The variational-iteration method is used to solve the derived time fractional KdV equation. The calculations of the solution are carried out for different values of the time fractional order. These calculations show that the time fractional can be used to modulate the electrostatic potential wave instead of adding a higher order dissipation term to the KdV equation. The results of the present investigation may be applicable to some plasma environments, such as the ionosphere plasma.

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Author Keywords: ion-acoustic waves; Euler-Lagrange equation; Riemann-Liouville fractional derivative; fractional KdV equation; variational-iteration method

**KeyWords Plus:** VARIATIONAL-ITERATION METHOD; DIFFERENTIAL-EQUATIONS; CLASSICAL FIELDS; SOLITARY WAVES; DERIVATIVES; FORMULATION; MECHANICS; PROPAGATION; PRINCIPLES; MEDIA

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