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Research Article

Approximation Solutions for Local Fractional Schrödinger Equation in the One-Dimensional Cantorian System

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The local fractional Schrödinger equations in the one-dimensional Cantorian system are investigated. The approximations solutions are obtained by using the local fractional series expansion method. The obtained solutions show that the present method is an efficient and simple tool for solving the linear partial differentiable equations within the local fractional derivative.

1. Introduction

As it is known, in classical mechanics, the equations of motions are described as Newton's second law, and the equivalent formulations become the Euler-Lagrange equations and Hamilton's equations. In quantum mechanics, Schrödinger's equation for a dynamic system like Newton's law plays an important role in Newton's mechanics and conservation of energy. Mathematically, it is a partial differential equation, which is applied to describe how the quantum state of a physical system changes in time [1, 2]. In this work, the solutions of Schrödinger equations were investigated within the various methods [3–12] and other references therein.

Recently, the fractional calculus [13–30], which is different from the classical calculus, is now applied to practical techniques in many branches of applied sciences and engineering. Fractional Schrödinger's equation was proposed by Laskin [31] via the space fractional quantum mechanics, which is based on the Feynman path integrals, and some properties of fractional Schrödinger's equation are investigated by Naber [32]. In present works, the solutions of fractional Schrödinger equations were considered in [33–38].

Classical and fractional calculus cannot deal with nondifferentiable functions. However, the local fractional calculus (also called fractal calculus) [39–56] is best candidate and has been applied to model the practical problems in engineering, which are nondifferentiable functions. For example, the systems of Navier-Stokes equations on Cantor sets with local fractional derivative were discussed in [42]. The local fractional Fokker-Planck equation was investigated in [43]. The basic theory of elastic problems was considered in [44]. The anomalous diffusion with local fractional derivative was researched in [48–50]. Newtonian mechanics with local fractional derivative was proposed in [51]. The fractal heat transfer in silk cocoon hierarchy and heat conduction in a semi-infinite fractal bar were presented in [53–55] and other references therein.

More recently, the local fractional Schrödinger equation in three-dimensional Cantorian system was considered in [56] as

$$i^{\alpha} h_{\alpha} \frac{\partial^{\alpha} \psi_{\alpha}(x,y,z,t)}{\partial t^{\alpha}} = -\frac{{h_{\alpha}}^{2}}{2m} \nabla^{2\alpha} \psi_{\alpha}(x,y,z,t) + V_{\alpha}(x,y,z)\, \psi_{\alpha}(x,y,z,t), \tag{1}$$

where the local fractional Laplace operator is [39, 40, 42]

$$\nabla^{2\alpha} = \frac{\partial^{2\alpha}}{\partial x^{2\alpha}} + \frac{\partial^{2\alpha}}{\partial y^{2\alpha}} + \frac{\partial^{2\alpha}}{\partial z^{2\alpha}}, \tag{2}$$

the wave function $\psi_\alpha(x,y,z,t)$ is a local fractional continuous function [39, 40], and the local fractional differential operator is given by [39, 40]

$$f^{(\alpha)}(x_0) = \frac{d^\alpha f(x)}{dx^\alpha}\Big|_{x=x_0} = \lim_{x\to x_0}\frac{\Delta^\alpha(f(x)-f(x_0))}{(x-x_0)^\alpha}, \quad (3)$$

with $\Delta^\alpha(f(x)-f(x_0)) \cong \Gamma(1+\alpha)\Delta(f(x)-f(x_0))$.

The local fractional Schrödinger equation in two-dimensional Cantorian system can be written as

$$i^\alpha h_\alpha \frac{\partial^\alpha \psi_\alpha(x,y,t)}{\partial t^\alpha} = -\frac{{h_\alpha}^2}{2m}\nabla^{2\alpha}\psi_\alpha(x,y,t) + V_\alpha(x,y)\psi_\alpha(x,y,t), \quad (4)$$

where the local fractional Laplace operator is given by

$$\nabla^{2\alpha} = \frac{\partial^{2\alpha}}{\partial x^{2\alpha}} + \frac{\partial^{2\alpha}}{\partial y^{2\alpha}}. \quad (5)$$

The local fractional Schrödinger equation in one-dimensional Cantorian system is presented as

$$i^\alpha h_\alpha \frac{\partial^\alpha \psi_\alpha(x,t)}{\partial t^\alpha} = -\frac{{h_\alpha}^2}{2m}\frac{\partial^{2\alpha}}{\partial x^{2\alpha}}\psi_\alpha(x,t) + V_\alpha(x)\psi_\alpha(x,t), \quad (6)$$

where the wave function $\psi_\alpha(x,t)$ is local fractional continuous function.

With the potential energy $V_\alpha = 0$, the local fractional Schrödinger equation in the one-dimensional Cantorian system is

$$i^\alpha h_\alpha \frac{\partial^\alpha \psi_\alpha(x,t)}{\partial t^\alpha} = -\frac{{h_\alpha}^2}{2m}\frac{\partial^{2\alpha}}{\partial x^{2\alpha}}\psi_\alpha(x,t). \quad (7)$$

In this paper our aim is to investigate the nondifferentiable solutions for local fractional Schrödinger equations in the one-dimensional Cantorian system by using the local fractional series expansion method [49]. The organization of the paper is organized as follows. In Section 2, we introduce the local fractional series expansion method. Section 3 is devoted to the solutions for local fractional Schrödinger equations. Finally, conclusions are given in Section 4.

2. The Local Fractional Series Expansion Method

According to local fractional series expansion method [49], we consider the following local fractional differentiable equation:

$$\phi_t^\alpha = L_\alpha \phi, \quad (8)$$

where L_α is the linear local fractional operator and ϕ is a local fractional continuous function.

In view of (8), the multiterm separated functions with respect to x, t are expressed as follows:

$$\phi(x,t) = \sum_{i=0}^{\infty}\varphi_i(t)\psi_i(x), \quad (9)$$

where $\varphi_i(t)$ and $\psi_i(x)$ are the local fractional continuous function.

There are nondifferentiable terms, which are written as

$$\varphi_i(t) = \chi_i \frac{t^{i\alpha}}{\Gamma(1+i\alpha)}, \quad (10)$$

where χ_i is a coefficient.

In view of (10), we get

$$\phi(x,t) = \sum_{i=0}^{\infty}\chi_i\frac{t^{i\alpha}}{\Gamma(1+i\alpha)}\psi_i(x). \quad (11)$$

Therefore,

$$\phi_t^\alpha = \sum_{i=0}^{\infty}\frac{\chi_{i+1}t^{i\alpha}}{\Gamma(1+i\alpha)}\psi_{i+1}(x), \qquad L_\alpha\phi = \sum_{i=0}^{\infty}\frac{\chi_i t^{i\alpha}}{\Gamma(1+i\alpha)}(L_\alpha\psi_i)(x). \quad (12)$$

Then, following (12), we have

$$\sum_{i=0}^{\infty}\frac{\chi_{i+1}t^{i\alpha}}{\Gamma(1+i\alpha)}\psi_{i+1}(x) = \sum_{i=0}^{\infty}\frac{\chi_i t^{i\alpha}}{\Gamma(1+i\alpha)}(L_\alpha\psi_i)(x). \quad (13)$$

Let $\chi_{i+1} = \chi_i = 1$; then

$$\sum_{i=0}^{\infty}\frac{t^{i\alpha}}{\Gamma(1+i\alpha)}\psi_{i+1}(x) = \sum_{i=0}^{\infty}\frac{t^{i\alpha}}{\Gamma(1+i\alpha)}(L_\alpha\psi_i)(x). \quad (14)$$

So, we have

$$\psi_{i+1}(x) = L_\alpha\psi_i, \quad (15)$$

where L_α is a linear local fractional operator.

In [49], the linear local fractional operators are considered as

$$L_\alpha = \frac{\partial^{2\alpha}}{\partial x^{2\alpha}}, \qquad L_\alpha = \frac{x^{2\alpha}}{\Gamma(1+2\alpha)}\frac{\partial^{2\alpha}}{\partial x^{2\alpha}}, \quad (16)$$

$$L_\alpha = \mu\frac{\partial^{2\alpha}}{\partial x^{2\alpha}}, \quad (17)$$

where μ is a constant.

Here, we consider the following operator:

$$L_\alpha = \eta\frac{\partial^{2\alpha}}{\partial x^{2\alpha}} + \gamma, \quad (18)$$

where η and γ are two constants.

Using the iterative formula (18), we obtain

$$\phi(x,t) = \sum_{i=0}^{\infty}\frac{t^{i\alpha}}{\Gamma(1+i\alpha)}\psi_i(x), \quad (19)$$

which is the solution of (8).

3. Approximation Solutions

Let us change (6) into the formula in the following form:

$$\frac{\partial^{\alpha}\psi_{\alpha}(x,t)}{\partial t^{\alpha}} = -\frac{h_{\alpha}}{2i^{\alpha}m}\frac{\partial^{2\alpha}}{\partial x^{2\alpha}}\psi_{\alpha}(x,t) + \frac{V_{\alpha}(x)}{i^{\alpha}h_{\alpha}}\psi_{\alpha}(x,t), \tag{20}$$

where the linear local fractional operator is

$$L_{\alpha} = -\frac{h_{\alpha}}{2i^{\alpha}m}\frac{\partial^{2\alpha}}{\partial x^{2\alpha}} + \frac{V_{\alpha}(x)}{i^{\alpha}h_{\alpha}}. \tag{21}$$

With $V_{\alpha}(x) = 1$, we have

$$L_{\alpha} = -\frac{h_{\alpha}}{2i^{\alpha}m}\frac{\partial^{2\alpha}}{\partial x^{2\alpha}} + \frac{1}{i^{\alpha}h_{\alpha}}, \tag{22}$$

so that

$$\frac{\partial^{\alpha}\psi_{\alpha}(x,t)}{\partial t^{\alpha}} = L_{\alpha}\psi_{\alpha}(x,t), \tag{23}$$

where

$$\psi_{\alpha}(x,0) = \frac{x^{2\alpha}}{\Gamma(1+2\alpha)}. \tag{24}$$

Using iteration relation (15), we set up

$$\psi_{\alpha,n+1}(x,t) = L_{\alpha}\psi_{a,n}(x,t), \tag{25}$$

and an initial value is given by

$$\psi_{a,0}(x,t) = \frac{x^{2\alpha}}{\Gamma(1+2\alpha)}. \tag{26}$$

Therefore, following (25), we get

$$\psi_{a,0}(x,t) = \frac{x^{2\alpha}}{\Gamma(1+2\alpha)}, \tag{27}$$

$$\begin{aligned}\psi_{a,1}(x,t) &= \left(-\frac{h_{\alpha}}{2i^{\alpha}m}\frac{\partial^{2\alpha}}{\partial x^{2\alpha}} + \frac{1}{i^{\alpha}h_{\alpha}}\right)\psi_{a,0}(x,t)\\ &= -\frac{h_{\alpha}}{2i^{\alpha}m} + \frac{1}{i^{\alpha}h_{\alpha}}\frac{x^{2\alpha}}{\Gamma(1+2\alpha)},\end{aligned} \tag{28}$$

$$\begin{aligned}\psi_{a,2}(x,t) &= \left(-\frac{h_{\alpha}}{2i^{\alpha}m}\frac{\partial^{2\alpha}}{\partial x^{2\alpha}} + \frac{1}{i^{\alpha}h_{\alpha}}\right)\psi_{a,1}(x,t)\\ &= \left(-\frac{h_{\alpha}}{2i^{\alpha}m}\frac{\partial^{2\alpha}}{\partial x^{2\alpha}} + \frac{1}{i^{\alpha}h_{\alpha}}\right)\\ &\quad\times\left(-\frac{h_{\alpha}}{2i^{\alpha}m} + \frac{1}{i^{\alpha}h_{\alpha}}\frac{x^{2\alpha}}{\Gamma(1+2\alpha)}\right)\\ &= -\frac{2}{2i^{2\alpha}m} + \frac{1}{i^{2\alpha}{h_{\alpha}}^{2}}\frac{x^{2\alpha}}{\Gamma(1+2\alpha)},\end{aligned} \tag{29}$$

$$\begin{aligned}\psi_{a,3}(x,t) &= \left(-\frac{h_{\alpha}}{2i^{\alpha}m}\frac{\partial^{2\alpha}}{\partial x^{2\alpha}} + \frac{1}{i^{\alpha}h_{\alpha}}\right)\psi_{a,2}(x,t)\\ &= \left(-\frac{h_{\alpha}}{2i^{\alpha}m}\frac{\partial^{2\alpha}}{\partial x^{2\alpha}} + \frac{1}{i^{\alpha}h_{\alpha}}\right)\\ &\quad\times\left(-\frac{1}{i^{2\alpha}m} + \frac{1}{i^{2\alpha}{h_{\alpha}}^{2}}\frac{x^{2\alpha}}{\Gamma(1+2\alpha)}\right)\\ &= -\frac{3}{2i^{3\alpha}mh_{\alpha}} + \frac{1}{i^{3\alpha}{h_{\alpha}}^{3}}\frac{x^{2\alpha}}{\Gamma(1+2\alpha)},\end{aligned} \tag{30}$$

$$\begin{aligned}\psi_{a,4}(x,t) &= \left(-\frac{h_{\alpha}}{2i^{\alpha}m}\frac{\partial^{2\alpha}}{\partial x^{2\alpha}} + \frac{1}{i^{\alpha}h_{\alpha}}\right)\psi_{a,3}(x,t)\\ &= \left(-\frac{h_{\alpha}}{2i^{\alpha}m}\frac{\partial^{2\alpha}}{\partial x^{2\alpha}} + \frac{1}{i^{\alpha}h_{\alpha}}\right)\\ &\quad\times\left(-\frac{3}{2i^{3\alpha}mh_{\alpha}} + \frac{1}{i^{3\alpha}{h_{\alpha}}^{3}}\frac{x^{2\alpha}}{\Gamma(1+2\alpha)}\right)\\ &= -\frac{4}{2i^{4\alpha}m{h_{\alpha}}^{2}} + \frac{1}{i^{4\alpha}{h_{\alpha}}^{4}}\frac{x^{2\alpha}}{\Gamma(1+2\alpha)},\end{aligned} \tag{31}$$

$$\vdots$$

$$\begin{aligned}\psi_{a,n}(x,t) &= \left(-\frac{h_{\alpha}}{2i^{\alpha}m}\frac{\partial^{2\alpha}}{\partial x^{2\alpha}} + \frac{1}{i^{\alpha}h_{\alpha}}\right)\psi_{a,n-1}(x,t)\\ &= -\frac{{h_{\alpha}}^{n-2}n}{2i^{n\alpha}m} + \frac{1}{i^{n\alpha}{h_{\alpha}}^{n}}\frac{x^{2\alpha}}{\Gamma(1+2\alpha)},\end{aligned} \tag{32}$$

and so on.

Hence, from (32) we obtain the solution of (23) as

$$\begin{aligned}\psi_{\alpha}(x,t) &= \sum_{n=0}^{\infty}\psi_{a,n}(x,t)\\ &= \sum_{n=0}^{\infty}\frac{t^{n\alpha}}{\Gamma(1+n\alpha)}\left(-\frac{{h_{\alpha}}^{n-2}n}{2i^{n\alpha}m} + \frac{1}{i^{n\alpha}{h_{\alpha}}^{n}}\frac{x^{2\alpha}}{\Gamma(1+2\alpha)}\right).\end{aligned} \tag{33}$$

We transform (7) into the following equation:

$$\frac{\partial^{\alpha}\psi_{\alpha}(x,t)}{\partial t^{\alpha}} = -\frac{h_{\alpha}}{2mi^{\alpha}}\frac{\partial^{2\alpha}}{\partial x^{2\alpha}}\psi_{\alpha}(x,t). \tag{34}$$

The initial condition is presented as

$$\psi_{\alpha}(x,0) = \frac{x^{2\alpha}}{\Gamma(1+2\alpha)}. \tag{35}$$

Applying (17), we can write the iterative relations as follows:

$$\begin{aligned}\psi_{\alpha,n+1}(x,t) &= L_{\alpha}\psi_{a,n}(x,t),\\ \psi_{a,0}(x,t) &= \frac{x^{2\alpha}}{\Gamma(1+2\alpha)},\end{aligned} \tag{36}$$

where

$$L_\alpha = -\frac{h_\alpha}{2mi^\alpha}\frac{\partial^{2\alpha}}{\partial x^{2\alpha}}. \tag{37}$$

From (36)–(38), we give the local fractional series terms as follows:

$$\psi_{a,0}(x,t) = \frac{x^{2\alpha}}{\Gamma(1+2\alpha)}, \tag{38}$$

$$\begin{aligned}\psi_{a,1}(x,t) &= -\frac{h_\alpha}{2mi^\alpha}\frac{\partial^{2\alpha}}{\partial x^{2\alpha}}\psi_{a,0}(x,t)\\ &= -\frac{h_\alpha}{2i^\alpha m},\end{aligned} \tag{39}$$

$$\psi_{a,2}(x,t) = -\frac{h_\alpha}{2mi^\alpha}\frac{\partial^{2\alpha}}{\partial x^{2\alpha}}\psi_{a,1}(x,t) = 0, \tag{40}$$

$$\begin{aligned}\psi_{a,3}(x,t) &= -\frac{h_\alpha}{2mi^\alpha}\frac{\partial^{2\alpha}}{\partial x^{2\alpha}}\psi_{a,2}(x,t) = 0,\\ &\vdots\end{aligned} \tag{41}$$

$$\psi_{a,n}(x,t) = -\frac{h_\alpha}{2mi^\alpha}\frac{\partial^{2\alpha}}{\partial x^{2\alpha}}\psi_{a,n-1}(x,t) = 0, \tag{42}$$

and so forth.

Hence, we have the nondifferentiable solution of (34) as follows:

$$\begin{aligned}\psi_\alpha(x,t) &= \sum_{n=0}^{\infty}\psi_{a,n}(x,t)\\ &= \frac{x^{2\alpha}}{\Gamma(1+2\alpha)} + \frac{h_\alpha}{2m}i^\alpha.\end{aligned} \tag{43}$$

4. Conclusions

In the work, we have obtained the nondifferentiable solutions for the local fractional Schrödinger equations in the one-dimensional Cantorian system by using the local fractional series expansion method. The present method is shown that is an effective method to obtain the local fractional series solutions for the partial differential equations within local fractional differentiable operator.

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References

[1] G. Teschi, *Mathematical Methods in Quantum Mechanics: With Applications to Schrödinger Operators*, vol. 99, American Mathematical Society, Providence, RI, USA, 2009.

[2] R. Shankar, *Principles of Quantum Mechanics*, vol. 233, Plenum Press, New York, NY, USA, 1994.

[3] M. D. Feit, J. A. Fleck, Jr., and A. Steiger, "Solution of the Schrödinger equation by a spectral method," *Journal of Computational Physics*, vol. 47, no. 3, pp. 412–433, 1982.

[4] M. Delfour, M. Fortin, and G. Payre, "Finite-difference solutions of a non-linear Schrödinger equation," *Journal of Computational Physics*, vol. 44, no. 2, pp. 277–288, 1981.

[5] A. Borhanifar and R. Abazari, "Numerical study of nonlinear Schrödinger and coupled Schrödinger equations by differential transformation method," *Optics Communications*, vol. 283, no. 10, pp. 2026–2031, 2010.

[6] A. S. V. R. Kanth and K. Aruna, "Two-dimensional differential transform method for solving linear and non-linear Schrödinger equations," *Chaos, Solitons & Fractals*, vol. 41, no. 5, pp. 2277–2281, 2009.

[7] A. M. Wazwaz, "A study on linear and nonlinear Schrödinger equations by the variational iteration method," *Chaos, Solitons & Fractals*, vol. 37, no. 4, pp. 1136–1142, 2008.

[8] M. M. Mousa, S. F. Ragab, and Z. Nturforsch, "Application of the homotopy perturbation method to linear and nonlinear Schrödinger equations," *Zeitschrift Fur Naturforschung A*, vol. 63, no. 3-4, pp. 140–144, 2008.

[9] N. H. Sweilam and R. F. Al-Bar, "Variational iteration method for coupled nonlinear Schrödinger equations," *Computers & Mathematics with Applications*, vol. 54, no. 7, pp. 993–999, 2007.

[10] S. T. Mohyud-Din, M. A. Noor, and K. I. Noor, "Modified variational iteration method for Schrödinger equations," *Mathematical and Computational Applications*, vol. 15, no. 3, pp. 309–317, 2010.

[11] J. Biazar and H. Ghazvini, "Exact solutions for non-linear Schrödinger equations by He's homotopy perturbation method," *Physics Letters A*, vol. 366, no. 1, pp. 79–84, 2007.

[12] A. Sadighi and D. D. Ganji, "Analytic treatment of linear and nonlinear Schrödinger equations: a study with homotopy-perturbation and Adomian decomposition methods," *Physics Letters A*, vol. 372, no. 4, pp. 465–469, 2008.

[13] A. Kilbas, H. M. Srivastava, and J. J. Trujillo, *Theory and Applications of Fractional Differential Equations*, Elsevier, Amsterdam, Netherlands, 2006.

[14] I. Podlubny, *Fractional Differential Equations*, Academic Press, San Diego, Calif, USA, 1999.

[15] K. B. Oldham and J. Spanier, *The Fractional Calculus*, Academic Press, New York, NY, USA, 1974.

[16] A. Carpinteri and F. Mainardi, *Fractals Fractional Calculus in Continuum Mechanics*, Springer, New York, NY, USA, 1997.

[17] K. S. Miller and B. Ross, *An Introduction to the Fractional Calculus and Fractional Differential Equations*, John Wiley & Sons, New York, NY, USA, 1993.

[18] F. Mainardi, *Fractional Calculus and Waves in Linear Viscoelasticity*, Imperial College Press, London, UK, 2010.

[19] R. L. Magin, *Fractional Calculus in Bioengineering*, Begerll House, Connecticut, Conn, USA, 2006.

[20] J. Klafter, S. C. Lim, and R. Metzler, *Fractional Dynamics in Physics: Recent Advances*, World Scientific, Singapore, 2011.

[21] G. M. Zaslavsky, *Hamiltonian Chaos and Fractional Dynamics*, Oxford University Press, Oxford, UK, 2008.

[22] J. West, M. Bologna, and P. Grigolini, *Physics of Fractal Operators*, Springer, New York, NY, USA, 2003.

[23] V. E. Tarasov, *Fractional Dynamics: Applications of Fractional Calculus to Dynamics of Particles, Fields and Media*, Springer, Berlin, Germany, 2011.

[24] J. A. T. Machado, A. C. J. Luo, and D. Baleanu, *Nonlinear Dynamics of Complex Systems: Applications in Physical, Biological and Financial Systems*, Springer, New York, NY, USA, 2011.

[25] D. Baleanu, K. Diethelm, E. Scalas, and J. J. Trujillo, *Fractional Calculus Models and Numerical Methods*, Series on Complexity, Nonlinearity and Chaos, World Scientific, Boston, Mass, USA, 2012.

[26] J. T. Machado, A. M. Galhano, and J. J. Trujillo, "Science metrics on fractional calculus development since 1966," *Fractional Calculus and Applied Analysis*, vol. 16, no. 2, pp. 479–500, 2013.

[27] H. Jafari and S. Seifi, "Homotopy analysis method for solving linear and nonlinear fractional diffusion-wave equation," *Communications in Nonlinear Science and Numerical Simulation*, vol. 14, no. 5, pp. 2006–2012, 2009.

[28] J. Hristov, "Heat-balance integral to fractional (half-time) heat diffusion sub-model," *Thermal Science*, vol. 14, no. 2, pp. 291–316, 2010.

[29] S. Momani and Z. Odibat, "Comparison between the homotopy perturbation method and the variational iteration method for linear fractional partial differential equations," *Computers & Mathematics with Applications*, vol. 54, no. 7-8, pp. 910–919, 2007.

[30] H. Jafari, H. Tajadodi, N. Kadkhoda, and D. Baleanu, "Fractional subequation method for Cahn-Hilliard and Klein-Gordon equations," *Abstract and Applied Analysis*, vol. 2013, Article ID 587179, 5 pages, 2013.

[31] N. Laskin, "Fractional Schrödinger equation," *Physical Review E*, vol. 66, no. 5, Article ID 056108, 7 pages, 2002.

[32] M. Naber, "Time fractional Schrödinger equation," *Journal of Mathematical Physics*, vol. 45, no. 8, article 3339, 14 pages, 2004.

[33] A. Ara, "Approximate solutions to time-fractional Schrödinger equation via homotopy analysis method," *ISRN Mathematical Physics*, vol. 2012, Article ID 197068, 11 pages, 2012.

[34] S. I. Muslih, O. P. Agrawal, and D. Baleanu, "A fractional Schrödinger equation and its solution," *International Journal of Theoretical Physics*, vol. 49, no. 8, pp. 1746–1752, 2010.

[35] S. Z. Rida, H. M. El-Sherbiny, and A. A. M. Arafa, "On the solution of the fractional nonlinear Schrödinger equation," *Physics Letters A*, vol. 372, no. 5, pp. 553–558, 2008.

[36] P. Felmer, A. Quaas, and J. Tan, "Positive solutions of the nonlinear Schrödinger equation with the fractional Laplacian," *Proceedings of the Royal Society of Edinburgh A*, vol. 142, no. 6, pp. 1237–1262, 2012.

[37] J. P. Dong and M. Y. Xu, "Some solutions to the space fractional Schrödinger equation using momentum representation method," *Journal of Mathematical Physics*, vol. 48, no. 7, Article ID 072105, 14 pages, 2007.

[38] A. Yildirim, "An algorithm for solving the fractional nonlinear Schrödinger equation by means of the homotopy perturbation method," *International Journal of Nonlinear Sciences and Numerical Simulation*, vol. 10, no. 4, pp. 445–450, 2009.

[39] X. J. Yang, *Advanced Local Fractional Calculus and Its Applications*, World Science, New York, NY, USA, 2012.

[40] X. J. Yang, *Local Fractional Functional Analysis and Its Applications*, Asian Academic, Hong Kong, China, 2011.

[41] X. J. Ma, H. M. Srivastava, D. Baleanu, and X. J. Yang, "A new Neumann series method for solving a family of local fractional Fredholm and Volterra integral equations," *Mathematical Problems in Engineering*, vol. 2013, Article ID 325121, 6 pages, 2013.

[42] X. J. Yang, D. Baleanu, and J. A. T. Machado, "Systems of Navier-Stokes equations on Cantor sets," *Mathematical Problems in Engineering*, vol. 2013, Article ID 769724, 8 pages, 2013.

[43] K. M. Kolwankar and A. D. Gangal, "Local fractional Fokker-Planck equation," *Physical Review Letters*, vol. 80, no. 2, pp. 214–217, 1998.

[44] A. Carpinteri, B. Chiaia, and P. Cornetti, "The elastic problem for fractal media: basic theory and finite element formulation," *Computers & Structures*, vol. 82, no. 6, pp. 499–508, 2004.

[45] A. Babakhani and V. D. Gejji, "On calculus of local fractional derivatives," *Journal of Mathematical Analysis and Applications*, vol. 270, no. 1, pp. 66–79, 2002.

[46] F. Ben Adda and J. Cresson, "About non-differentiable functions," *Journal of Mathematical Analysis and Applications*, vol. 263, no. 2, pp. 721–737, 2001.

[47] Y. Chen, Y. Yan, and K. Zhang, "On the local fractional derivative," *Journal of Mathematical Analysis and Applications*, vol. 362, no. 1, pp. 17–33, 2010.

[48] W. Chen, "Time-space fabric underlying anomalous diffusion," *Chaos Solitons Fractals*, vol. 28, pp. 923–929, 2006.

[49] A. M. Yang, X. J. Yang, and Z. B. Li, "Local fractional series expansion method for solving wave and diffusion equations on cantor sets," *Abstract and Applied Analysis*, vol. 2013, Article ID 351057, 5 pages, 2013.

[50] X. J. Yang, D. Baleanu, and W. P. Zhong, "Approximate solutions for diffusion equations on cantor space-time," *Proceedings of the Romanian Academy A*, vol. 14, no. 2, pp. 127–133, 2013.

[51] A. K. Golmankhaneh, V. Fazlollahi, and D. Baleanu, "Newtonian mechanics on fractals subset of real-line," *Romania Reports in Physics*, vol. 65, pp. 84–93, 2013.

[52] G. Jumarie, "Probability calculus of fractional order and fractional Taylor's series application to Fokker-Planck equation and information of non-random functions," *Chaos, Solitons & Fractals*, vol. 40, no. 3, pp. 1428–1448, 2009.

[53] C.-F. Liu, S.-S. Kong, and S.-J. Yuan, "Reconstructive schemes for variational iteration method within Yang-Laplace transform with application to fractal heat conduction problem," *Thermal Science*, Article ID 120826, p. 75, 2013.

[54] J. H. He, "Local fractional variational iteration method for fractal heat transfer in silk cocoon hierarchy," *Nonlinear Science Letters A*, vol. 4, no. 1, pp. 15–20, 2013.

[55] A. M. Yang, Y. Z. Zhang, and Y. Long, "The Yang-Fourier transforms to heat-conduction in a semi-infinite fractal bar," *Thermal Science*, p. 74, 2013.

[56] X. J. Yang, D. Baleanu, and J. A. T. Machado, "Mathematical aspects of Heisenberg uncertainty principle within local fractional Fourier analysis," *Boundary Value Problems*, vol. 2013, no. 1, pp. 131–146, 2013.