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Thermo-solute natural convection with heat and mass lines in a uniformly heated and soluted rectangular enclosure for low Prandtl number fluids

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ABSTRACT

Thermo-solute natural convection with heat and mass lines in a uniformly heated and soluted rectangular enclosure for low Prandtl number fluids is studied. The left and right walls are maintained at constant temperature and solute while the bottom and top walls are adiabatic and non-diffusive. The finite difference method, together with the successive over-relaxation (SOR) technique, is used to solve the flow governing equations after converted into the vorticity-stream function form. Heat and mass lines visualization techniques are used for the better visualization of energy and solute distribution in the enclosure. The results obtained in this study are compared with experimental and numerical those from literature and found to be in good agreement. The influence of Rayleigh number $\left(\mathrm{Ra} = 10^3, 10^4, 10^5\right)$, Prandtl number $(\mathrm{Pr} = 0.015, 0.025, 0.71)$, Lewis number $(\mathrm{Le} = 1, 2, 5)$, and Buoyancy ratio $(\mathrm{N} = -1, 0, 1)$ on streamlines, isotherms, isosolutes, heatlines, masslines, total heat and mass transfer are examined. The parameters mentioned above considerably influence the total heat and solute transfer rates; moreover, the heat and mass lines play significant roles in understanding the distribution of energy and solute transfers in the enclosure.

1. Introduction

The thermo-solute natural convection is a process of buoyancy driven flows induced by the combined temperature and solute gradients. Alternatively, the buoyancy force is developed by combined concentration and temperature gradients. Technical applications of this type of thermo-solute natural convection process are e.g., geophysics [1,2], solar collector [3], drying technology [4], food engineering [5], biomechanics [6], distillation [7], and building engineering [8]. Rectangular enclosures are widely employed in many industries. Examples include tank storage, energy transfer devices, reactor systems, solar collectors, and engine cooling systems. Liquid metals are characterized by a very low Prandtl number due to their very high heat diffusivity. Pr = 0.015 and Pr = 0.025 represent liquid mercury and liquid gallium respectively. Liquid metals are considered in many nuclear and non-nuclear processes. In the frame of the future generation of nuclear reactors, liquid metals are foreseen to be used as a primary coolant. In the non-nuclear energy generation, liquid metals are used as a heat transfer medium in solar plants, where the sunlight is reflected by numerous mirrors onto a heat exchanger operated with liquid metals.

Natural convection in three-dimensional rectangular enclosures utilizing a very low Prandtl number fluid (Pr = 0.008) has been investigated by Crunkleton et al. [9]. The influence of Rayleigh number and aspect ratio on flow structures and heat transfer have been discussed in detail. Zhang and his group members have been done some good works on low Prandtl number fluids. Effect of surface heat dissipation, flow pattern transition, and destabilization mechanism on thermocapillary convection for low Prandtl number fluids in shallow and deep annular pools have been analyzed in [10–12]. Xu and his group (Xu et al. [13]; Yu et al. [14]) studied transient natural convective heat transfer of a low Prandtl number fluid from a heated horizontal circular cylinder to its coaxial and inner coaxial triangular enclosures. Flow structures and heat transfer in different types of geometries utilizing low Prandtl number fluids have considered in [15–17]. Deshmukh et al. [18] investigated the natural convection in different aspect ratios cavities utilizing moderate Prandtl number fluid. Zhang et al. [19] have investigated double-diffusive Rayleigh–Bénard convection of a moderate Prandtl number binary mixture in cylindrical enclosures. On recent application, Liu and his group (Ma and Liu [20]; Ge et al. [21]) developed novel applications using liquid metals for cooling of electronic chips and high power devices.

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Locally Starplus-Compactness in *L*-Topological Spaces

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ABSTRACT
The notion of local starplus-compactness on an L-fuzzy topological space, which is an extension of the notion of local compactness in general topology, is introduced. It turns out that local starplus-compactness is finitely productive, closed hereditary and invariant under fuzzy continuous open surjections. Moreover, local starplus-compactness is a good extension of the notion of local compactness in general topology. Examples are included to show that local starplus-compactness is neither hereditary nor expansive, nor contractive.

KEYWORDS
L-fuzzy topological space; starplus-compactness; locally starplus-compactness; pseudo closed set

1. Introduction

The class of locally compact spaces is far more wider than the class of compact spaces. The locally compact spaces often arise in topology and applications of topology to geometry, analysis and algebra. For example, the study of locally compact abelian group forms the foundation of harmonic analysis. It is well known that every compact space is locally compact but the converse need not be true. For example, the Euclidean space $\mathbb{R}$ is locally compact but not compact. Topological manifolds share the local properties of Euclidean space and hence are locally compact. A locally compact space can be imbedded in a compact space, which is its compactification. One of the simplest compapctification of a space is the one point compactification, wherein one simply adjoins one new point to the space. The classical example of one point compactification is the embedding of the Gaussian plane of complex numbers into the Riemann sphere. The category of locally compact spaces has been applied in almost every subdiscipline of mathematics and hence it is important to formulate an appropriate version of local compactness in the *L*-fuzzy setting.

The notion of compactness in fuzzy topology have been thoroughly investigated by various authors (see [1–13]). However, a satisfactory theory for the localisation of the notion of compactness in fuzzy topology has not been established because of the absence of proper definition of subspace on an arbitrary fuzzy subset. Kudri and Warner [11] defined a notion of *L*-fuzzy local compactness on an *L*-fuzzy topology by using *very compact neighbourhood* instead of compact neighbourhood of a fuzzy point. In [9] Kohli and Prasannan introduced the notion of starplus-compactness for a fuzzy topological space and successfully applied it to study fuzzy topologies and fuzzy uniformities on function spaces [12,14].

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Existence and Stability of Equilibrium Points in the Problem of a Geo-Centric Satellite Including the Earth's Equatorial Ellipticity

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Abstract: This paper deals with the existence and stability of the equilibrium points in the problem of a geo-centric satellite including the earth's equatorial ellipticity. We have determined the equations of motion of the geo-centric satellite which include the earth's equatorial ellipticity parameter Γ (the satellite's angular position relative to the minor axis of the earth's equatorial section) and then we have investigated the existence and stability of equilibrium points. It is observed that there exists an infinite number of equilibrium points which lie on a circle for different values of Γ. It is shown that the effect of the earth's equatorial ellipticity parameter Γ on the location of equilibrium points is very small (i.e., the coordinates of the equilibrium points are different after the fifth decimal places). Further, we have observed that the collinear points are unstable for different values of Γ. The non-collinear points lying on the y-axis are unstable for different values of Γ. We have also found that some of the non-collinear points lying on the circle are stable and others are unstable for different values of Γ.

Keywords: *geo-centric satellite; earth's equatorial ellipticity; equilibrium points and stability.*

Mathematics Subject Classification (2010): 70F07, 70F10, 70F15.

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Resonance in the Motion of a Geocentric Satellite Due to Poynting-Robertson Drag and Equatorial Ellipticity of the Earth

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Abstract

In this paper, the problem of resonance in a motion of a geocentric satellite is numerically investigated under the consolidated gravitational forces of the Sun, the Earth including Earth's equatorial ellipticity parameter and Poynting-Robertson (P-R) drag. We are presuming that bodies lying on an ecliptic plane are the Sun and the Earth, and satellite on orbital plane. Resonance is monitored between satellite's mean motion and average angular velocity of the Earth around the Sun, and also between satellite's mean motion and equatorial ellipticity parameter of the Earth. We also perform a systematic and thorough analysis in an attempt to understand the effect of Earth's equatorial ellipticity parameter and P-R drag on time period and amplitude of oscillations at different critical points.

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Some strong and weak form of z-continuity via Cl^* [1]

A. R. Prasannan, J. Biswas

Abstract

This paper mainly dedicated on overview of zero sets in Ideal topological spaces. We also introduce a new class of functions which generalizes the class of continuous functions and investigate its position in the hierarchy of continuous functions on Ideal topological spaces. Moreover, these new sets (zero*-$\mathcal{I}$-set) which is a pragmatic approach to characterize completely $Hausdorff$ spaces.

2010 Mathematics Subject Classification: 54C05, 54C08, 54C10.
Key words and phrases: Ideal, zero sets, z-open, z-continuous, Completely Hausdorff.

1 Introduction

In 1933, Kuratowski [13] applied the notion of topological ideals in topological spaces and later on Vidyanathswamy [18] formally applied the word topological ideal in the study of spaces which have properties "locally" and which in several interesting cases implies that space has the property "globally". A systematic study of the general topological space via ideals was initiated by Hamlett and Janković in [8, 9, 10, 11, 12] and gave different open sets using "cl*"-closure operator. Subsequently different authors generalized and extended the concept of open sets, separation axioms, compactness, connectedness, resolvability, decomposition of continuity, etc. to ideal topological spaces [4, 5, 6, 7, 14, 15]. Newcomb [14] applied the concept of ideal in defining $\mathcal{I}$-compactness. Singal et.al. [16] introduced a new characterization of completely $Hausdorff$ spaces by means of zero sets. Using this concept, we characterize completely $Hausdorff$ space using topological ideal. In the process, we have to define many new terms and applied them to get desired results.

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New separation axioms in soft topological space

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Abstract. The more general form of soft separation axioms are defined in soft topological spaces and its interrelationship with existing soft separation axioms are studied. It was interesting to go through separation axiom as in [23] shown that there are limited relation between T_i axioms (i = 0,1,2,3). In this paper, it is shown that these axioms are stronger than the existing separation axioms in soft topological spaces.

2010 AMS Classification: 22A99, 54A40, 06D72, 03E72, 20N25

Keywords: Soft set, Soft points, Soft T_0-space, Soft T_1-space, Soft T_2-space, Soft T_3-space, Parametric soft T_0-space, Parametric soft T_1-space, Parametric soft T_2-space, Absolute soft T_0-space, Absolute soft T_1-space, Absolute soft T_2-space.

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1. Introduction

The notion of soft set theory was introduced by Moldstov as a new approach for modelling uncertainties [20] to resolve many complicated problems existing in engineering, economics and enviormental areas. Mathematical tools like Fuzzy set, Rough set, Vague set, etc. have some difficulties and drawback while dealing with uncertainties which are explained in [19, 21]. Moldstov [20, 21] successfully applied soft set theory in game theory, operation research, soft analysis, probability, Perron integration, Riemann integration and theory of measurement. For interested reader who are looking for further work of soft sets one may refer the following paper for better understanding of soft set in decision making and fuzzy soft sets in [17].

Maji et.al. [19] have defined and studied different operations on soft sets like soft intersection, soft union, soft subset, etc. Then Pei-Miao [22] and Chen [9] extended the work of Maji et.al.[19]. The properties and applications of soft set theory were studied increasingly in [4]. Căgman and Enginoglu [7] redefined the operations of soft sets and constructed a uni-int decision-making method by using these new operations and developed new variant of soft set theory. Then to make compaction with the

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Resonance in the Motion of a Geo-Centric Satellite Due to the Poynting-Robertson Drag and Oblateness of the Earth

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Abstract: In this paper, we have investigated resonances in a geo-centric satellite under the gravitational effect of the Sun, the Earth, oblateness of the Earth and the Poynting-Robertson (P-R) drag. It is found that resonances occur due to the commensurability between satellite's mean motion and average angular velocity of the Earth around the Sun, and also between the satellite's mean motion and average angular velocity of the regression angle. Amplitudes and time periods of the oscillation at the resonance points have been determined. Effects of oblateness and P-R drag on the amplitudes and time periods of oscillation at different resonance points have been analyzed graphically. We have also compared the values of the amplitude and time period of oscillations due to the oblateness parameter and P-R drag. We have observed that amplitude as well as the time period decreases as ϕ (an orbital angle of the Earth around the Sun) increases between -90^0 to 90^0, and the effect of the P-R drag parameter is minor on the amplitudes and time periods. Also, the amplitude and time-period decrease as ψ increases between -90^0 to 90^0.

Keywords: *three-body problem; ecliptic plane; orbital plane; resonance; Poynting-Robertson drag; oblateness.*

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