



# A note on Turán type and mean inequalities for the Kummer function

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## ABSTRACT

Turán-type inequalities for combinations of Kummer functions involving  $\Phi(a \pm v, c \pm v, x)$  and  $\Phi(a, c \pm v, x)$  have been recently investigated in [Á. Baricz, Functional inequalities involving Bessel and modified Bessel functions of the first kind, Expo. Math. 26 (3) (2008) 279–293; M.E.H. Ismail, A. Laforgia, Monotonicity properties of determinants of special functions, Constr. Approx. 26 (2007) 1–9]. In the current paper, we resolve the corresponding Turán-type and closely related mean inequalities for the additional case involving  $\Phi(a \pm v, c, x)$ . The application to modeling credit risk is also summarized.

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## 1. Introduction

The Kummer confluent hypergeometric function is given by

$$\Phi(\alpha, \beta, x) = \sum_{n=0}^{\infty} \frac{(\alpha)_n x^n}{(\beta)_n n!},$$

where  $(\alpha)_n$  is the Pochhammer symbol defined by  $(\alpha)_n = \Gamma(\alpha + n)/\Gamma(\alpha) = \alpha(\alpha + 1) \cdots (\alpha + n - 1)$  for  $n \in \mathbb{N}$ ,  $(\alpha)_0 = 1$ ,  $(\alpha + 1)_{-1} = \frac{1}{\alpha}$ , and the Gamma function is  $\Gamma(x) = \int_0^{\infty} t^{x-1} e^{-t} dt$ , for  $x > 0$ .

Inequalities involving contiguous Kummer confluent hypergeometric functions of the form  $\Phi(a \pm v, c \pm v, x)$  and  $\Phi(a, c \pm v, x)$  were presented in Theorem 2 of [4] and Theorem 2.7 of [11]. These inequalities are of the Turán type [15] in the case that  $v = 1$ . In the present note, we resolve the remaining Turán-type case involving  $\Phi(a \pm 1, c, x)$  and extend it to include  $\Phi(a \pm v, c, x)$ ,  $v \in \mathbb{N}$ . We then establish a closely related mean inequality that provides simultaneous upper and lower bounds for  $\Phi(a, c, x)$ . Turán-type inequalities, which are of independent interest, also have important applications in Information Theory (as demonstrated by McEliece, Reznick, and Shearer in their paper [12]) and in modeling credit risk, as summarized below.

In particular, Carey and Gordy [9] model a lending relationship in which the bank has an option to foreclose upon the borrower at any time. Following the seminal models of Merton [13] and Black and Cox [6], it is assumed that the value of the firm's assets follows a geometric Brownian motion. It is shown that the bank's optimal foreclosure threshold solves a first order condition involving a ratio of contiguous Kummer functions, which implies that a Turán-type inequality for the Kummer function arises naturally in studying the comparative statics of the model. A proof of this key Turán-type

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Mathematical Analysis in Interdisciplinary Research Ioannis N. Parasidis,Efthimios Providas,Themistocles M. Rassias,2022-03-10 This contributed volume provides an extensive account of research and expository papers in a broad domain of mathematical analysis and its various applications to a multitude of fields Presenting the state of the art knowledge in a wide range of topics the book will be useful to graduate students and researchers in theoretical and applicable interdisciplinary research The focus is on several subjects including optimal control problems optimal maintenance of communication networks optimal emergency evacuation with uncertainty cooperative and noncooperative partial differential systems variational inequalities and general equilibrium models anisotropic elasticity and harmonic functions nonlinear stochastic differential equations operator equations max product operators of Kantorovich type perturbations of operators integral operators dynamical systems involving maximal monotone operators the three body problem deceptive systems hyperbolic equations strongly generalized preinvex functions Dirichlet characters probability distribution functions applied statistics integral inequalities generalized convexity global hyperbolicity of spacetimes Douglas Rachford methods fixed point problems the general Rodrigues problem Banach algebras affine group Gibbs semigroup relator spaces sparse data representation Meier Keeler sequential contractions hybrid contractions and polynomial equations Some of the works published within this volume provide as well guidelines for further research and proposals for new directions and open problems

*Applied Mathematical Analysis and Computations II* Divine Wanduku,Shijun Zheng,Haomin Zhou,Zhan Chen,Andrew Sills,Ephraim Agyingi,2024-11-15 This volume convenes selected

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and optimal control techniques and to all control engineers dealing with system uncertainties      **Analysis as a Life** Sergei Rogosin,Ahmet Okay Çelebi,2019-01-30 This is a book comprising selected papers of colleagues and friends of Heinrich Begehr on the occasion of his 80th birthday It aims at being a tribute to the excellent achievements of Heinrich Begehr in complex analysis and complex differential equations and especially to his prominent role as one of the creators and long time leader of the International Society for Analysis its Applications and Computation ISAAC      *Dynamic and Stochastic Efficiency Analysis* Jatikumar Sengupta,2000 This book extends the dynamic and stochastic analysis of economic efficiency by using the recent techniques of data envelopment analysis New results and applications of these techniques in numerous areas of economics finance and management are provided including treatment of private sector industries portfolio models in finance quality control techniques in managerial performance the role of market competition policy applications in investment models in finance risk aversion and efficiency and technology and innovation The most up to date tools of efficiency analysis developed here will be valuable for students and researchers in operations research applied management science and applied microeconomics      Astronomical Image and Data Analysis J.-L. Starck,F. Murtagh,2013-04-17 When we consider the ever increasing amount of astronomical data available to us we can well say that the needs of modern astronomy are growing by the day Ever better observing facilities are in operation The fusion of information leading to the coordination of observations is of central importance The methods described in this book can provide effective and efficient ripostes to many of these issues Much progress has been made in recent years on the methodology front in line with the rapid pace of evolution of our technological infrastructures The central themes of this book are information and scale The approach is astronomy driven starting with real problems and issues to be addressed We then proceed to comprehensive theory and implementations of demonstrated efficacy The field is developing rapidly There is little doubt that further important papers and books will follow in the future Colleagues we would like to acknowledge include Alexandre Aussem Albert Bijaoui Francis Bonnarel Jonathan G Campbell Ghada Jammal Rene Gastaud Pierre Francis Honore Bruno Lopez Mireille Louys Clive Page Eric Pantin Philippe Querre Victor Racine Jerome Rodriguez and Ivan Valtchanov      **Dietary Fiber: Properties, Recovery, and Applications** Charis M. Galanakis,2019-06-15 Dietary Fiber Properties Recovery and Applications explores the properties and health effects of dietary fiber along with new trends in recovery procedures and applications The book covers the most trending topics of dietary fiber applications emphasizing polyphenol properties bioavailability and metabolomics target sources recovery and emerging technologies technological aspects stability during processing and applications in the food beverage and nutraceutical sectors Written by a team of experts in the field of dietary fiber this book is ideal for chemists food scientists technologists new product developers and academics      Journal of Mathematical Analysis and Applications ,1985-10      Food Authentication Contantinos A. Georgiou,Georgios P. Danezis,2017-02-21 The determination of food authenticity is a vital component of quality control Its importance has been highlighted in recent years

by high profile cases in the global supply chain such as the European horsemeat scandal and the Chinese melamine scandal which led to six fatalities and the hospitalisation of thousands of infants As well as being a safety concern authenticity is also a quality criterion for food and food ingredients Consumers and retailers demand that the products they purchase and sell are what they purport to be This book covers the most advanced techniques used for the authentication of a vast number of products around the world The reader will be informed about the latest pertinent analytical techniques Chapters focus on the novel techniques markers that have emerged in recent years An introductory section presents the concepts of food authentication while the second section examines in detail the analytical techniques for the detection of fraud relating to geographical botanical species and processing origin and production methods of food materials and ingredients Finally the third section looks at consumer attitudes towards food authenticity the application of bioinformatics to this field and the Editor s conclusions and future outlook Beyond being a reference to researchers working in food authentication it will serve as an essential source to analytical scientists interested in the field and food scientists to appreciate analytical approaches This book will be a companion to under and postgraduate students in their wander in food authentication and aims to be useful to researchers in universities and research institutions

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