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Preface to the Special Issue in honor of D. H. Phong

This issue of Pure and Applied Mathematics Quarterly is dedicated to Professor D.H. Phong on the occasion of his 65th birthday.

D.H. Phong was born in Nam Dinh, situated in northern Vietnam, on August 30, 1953. He attended high-school at Lycée Jean-Jacques Rousseau in Saigon, and spent a year at the École Polytechnique Fédérale in Lausanne, Switzerland before moving to the United States to study at Princeton University. Phong obtained his B.A. from Princeton, went on to graduate study at Princeton under Elias M. Stein, obtaining his Ph.D degree in 1977, at the age of 24. After postdoctoral positions at the University of Chicago and the Institute of Advanced Study, Phong took a faculty position at Columbia University where he is currently Professor of Mathematics.

Phong's thesis was on estimates for PDEs on pseudoconvex domains, solving a problem suggested to him by Joseph J. Kohn. Soon afterwards he began a series of incredibly fruitful and impactful collaborations. His work with Charles Fefferman yielded the now classical *Fefferman-Phong inequality* on the positivity of pseudodifferential operators. In a series of works with his former advisor E.M. Stein in the 1980s and 1990s, Phong introduced the general concept of singular Radon transforms and proved fundamental and deep estimates for oscillatory integral operators. In a completely different direction, beginning in the mid-1980s, Phong began a decades-long collaboration with Eric D'Hoker on string theory. This prodigious collaboration has spanned over 30 years, and resulted in over 50 publications lying at the heart of the mathematics and physics of string theory. In particular they found the Seiberg-Witten solution of the gauge theory with adjoint matter, solving in the process the long-standing problem of finding a Lax pair with spectral parameter for elliptic Calogero-Moser systems defined by general simple Lie algebras. In the early 2000s, D'Hoker-Phong made a major breakthrough by evaluating the vacuum amplitude and the 4-point superstring amplitude

at two loops, a milestone in superstring perturbation theory and a tour de force of calculation. Phong's work on string and gauge theories also led to some foundational joint works with Igor M. Krichever on integrable models. One major outcome is a new Hamiltonian approach to integrable models, by which a universal symplectic form can be constructed from the Lax pair.

A new phase of Phong's work began in the early 2000s with a long collaboration with Jacob Sturm on complex geometry, starting with a fundamental result on the stability of integrals of powers of holomorphic functions. They went on to make major contributions to the study of the geodesics on the space of Kähler metrics, estimates for degenerate complex Monge-Ampère equations, and the behavior of the Kähler-Ricci flow. Recently, Phong has begun a new investigation with Sébastien Picard and Xiangwen Zhang on geometric flows inspired by mathematical physics, and in particular by the heterotic string. In addition to the above, Phong has made many other important and foundational contributions to complex analysis and PDE.

Phong's fundamental work in mathematics and physics research has been recognized by numerous distinctions: he was an AMS Fellow and an Alfred P. Sloan Fellow; he was an invited speaker at the International Congress of Mathematicians in Zurich in 1994; he won the 2009 Stefan Bergman Prize; and was elected a member of the American Academy of Arts and Sciences in 2013.

Phong has been an outstanding citizen in the mathematical profession. He served as Chair of the Mathematics Department at Columbia University from 1995 to 1998. He has served on the editorial boards of many mathematical journals including the Annales scientifiques de l'École normale supérieure, the Journal de l'Institut Mathématique de Jussieu, Transactions of the AMS, the Annals of PDE, the Asian Journal of Mathematics, the New York Journal of Mathematics and Pure and Applied Mathematics Quarterly. Phong is currently Editor-in-Chief of Mathematical Research Letters. He has served on the scientific boards of the Centre de Recherches Mathématiques in Montreal, the Fields Institute in Toronto, and the American Institute of Mathematics in San Jose.

Phong has held visiting positions at the École Polytechnique, Université de Rennes, Université de Strasbourg, École Normale Supérieure, Institut de Mathématiques de Toulouse, Université de Paris-Sud, Institute for Theoretical and Experimental Physics in Moscow, and the Université Pierre et Marie Curie. Phong held the Aisenstadt chair at the Centre de Recherches Mathématiques in Montreal, and a Distinguished Visiting Professorship at the University of California, Irvine.

Phong has advised more than 20 PhD students, and has mentored many postdocs who served as Ritt Assistant Professors at Columbia. All will attest to how Phong's point of view has profoundly influenced their taste and opinions about mathematics. An indication of the admiration of Phong amongst his former students, postdocs and colleagues is the ease with which we obtained high quality submissions for this special issue.

We solicited submissions for this issue in 2018, the year of Phong's 65th birthday. Due to the usual delays in receiving and processing articles, this issue is now appearing in print some years later. We wish Phong, rather belatedly, a happy 65th birthday!

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