YUNQING TANG TO RECEIVE 2022 SASTRA RAMANUJAN PRIZE

The 2022 SASTRA Ramanujan Prize will be awarded to Dr. YUNQING TANG of the University of California, Berkeley, USA. This annual $10,000 prize is for outstanding contributions by individuals not exceeding the age of 32 in areas of mathematics influenced by Ramanujan in a broad sense. The age limit has been set at 32 because Ramanujan achieved so much in his brief life of 32 years. The prize will be awarded at an International Conference in Number Theory during December 20-22, 2022, at SASTRA University in Kumbakonam (Ramanujan's hometown) in South India.

Dr. YUNQING TANG is one of the best young number theorists to emerge in recent years worldwide. She, by herself and in collaboration, has established a number of striking results on some central problems in arithmetic geometry and number theory.

Yunqing Tang completed her PhD in 2016 under the supervision of Mark Kisin at Harvard University. In her thesis (published in *Compositio Mathematica* in 2018) she established a new special case of the Ogus conjecture concerning cycles in de Rham cohomology of abelian varieties encoding information from crystalline cohomology.

Her recent joint work with Ananth Shankar in the *Duke Math. Journal* (2020) is quite striking. There are not many theorems in number theory which establish an infinitude of a sparse set of primes- a key prototype being a result of Noam Elkies, showing the infinitude of the set of supersingular primes for an elliptic curve over the rationals. Ananth Shankar and Tang show that any abelian surface with real multiplication has infinitely many primes with split reduction. In a follow-up paper with Davesh Maulik and Ananth Shankar in *Compositio Mathematica* in 2022, Tang establishes a similar result in a function field setting. And then, in recent joint work (*Forum of Math, π*) with Ananth Shankar, Arul Shankar and Salim Tayou, Tang proves the analogous theorem in the setting of $K3$ surfaces; with Maulik and Shankar, Tang has yet another paper *(Inventiones 2022)* establishing a function field analogue of the $K3$ surface setting result. The ideas in this quartet of papers are expected to lead to further major results of this type.

Tang's most recent joint work with Frank Calegari and Vesselin Dimitrov on modular equations is of great significance and also has ties with Ramanujan's own work. In the theory of elliptic integrals, there is an important parameter called the modulus. A modular equation is an algebraic (polynomial) equation that involves the moduli of two related elliptic integrals. Modular equations were of special interest to Ramanujan who found amazing and important examples. Inversion of the power series representation of moduli that satisfy modular equations, leads to algebraic functions. Large portions of Ramanujan's Notebooks are devoted to explicit modular equations which then yield nice examples of algebraic functions. It turns out that algebraic functions in the ring of power series with integer coefficients which can be lifted to the extended complex plane minus three points, always arise from the special class of classical modular curves, namely from modular equations of the type considered by Ramanujan. If the problem is turned around, then one finds that holomorphic functions with algebraic number/rational coefficients that are invariant under actions of congruence subgroups Γ of $SL_2(\mathcal{Z})$ are classical modular functions with the remarkable property that the denominators of the coefficients in their power series expansion are bounded. A long-standing conjecture of Atkin and Swinnerton-Dyer is that if these algebraic functions are not invariant under any congruence subgroup,

then the denominators are unbounded. This *unbounded denominators conjecture* has been brilliantly proved by Tang in collaboration with Calegari and Dimitrov.

In summary, Tang's works display a remarkable combination of sophisticated techniques, in which the arithmetic and geometry of modular curves and of Shimura varieties play a central role, and her results and methods are bound to have major impact on future research in this area.

Yunqing Tang who was born in China, completed her BSc at Peking University in 2011, following which she went to Harvard University for her graduate studies. She completed her PhD in 2016 at Harvard under the direction of Mark Kisin. She then was a Post-doctoral Member at the Institute for Advanced Study in Princeton in 2016-17, and an Instructor at Princeton University during 2017-2020. After spending the year 2020-2021 at the CNRS in Orsay, France, as a Chargée de Recherche, she returned to Princeton for the year 2021-22 as an Assistant Professor. She joined the University of California, Berkeley as an Assistant Professor in July 2022. She is one of the deepest and most creative mathematicians of her age, and her wide ranging contributions are bound to have impact in the decades ahead.

The 2022 SASTRA Ramanujan Prize Committee comprised: Krishnaswami Alladi - Chair (University of Florida), Don Blasius (University of California, Los Angeles), Dan Goldston (San Jose State University), Ken Ono (University of Virginia), Jonathan Pila (Oxford University), Zeev Rudnick (Tel Aviv University) and Cam Stewart (University of Waterloo). Tang, who was the overwhelming choice of the Committee, joins the illustrious group of winners of the SASTRA Ramanujan Prize.

Krishnaswami Alladi
Chair - SASTRA Ramanujan
Prize Committee

YUNQING TANG - 2022 SASTRA RAMANUJAN PRIZE WINNER

Citation

YUNQING TANG is awarded the 2022 SASTRA Ramanujan Prize for having established, by herself and in collaboration, a number of striking results on some central problems in arithmetic geometry and number theory. The prize notes that her works display a remarkable combination of sophisticated techniques, in which the arithmetic and geometry of modular curves and of Shimura varieties play a central role, and have strong links with the discoveries of Srinivasa Ramanujan in the area of modular equations. The prize recognizes her important 2016 PhD thesis at Harvard published in *Compositio Mathematica* in 2018 in which she established a new special case of the Ogus conjecture concerning cycles in de Rham cohomology of abelian varieties. The prize also recognizes her striking recent joint work with Ananth Shankar in the *Duke Math. Journal* (2020) which shows that any abelian surface with real multiplication has infinitely many primes with split reduction. Establishing function field versions of number theoretic results is a major direction of development, and the prize notes that in a follow-up paper with Davesh Maulik and Ananth Shankar in *Compositio Mathematica* in 2022, Dr. Tang established a similar result in a function field setting. In two further recent significant joint papers, the first in *Forum of Math, π* with Ananth Shankar, Arul Shankar and Salim Tayou, Dr. Tang proved the analogous theorem in the setting of $K3$ surfaces, and in the second with Davesh Maulik and Ananth Shankar in *Inventiones Mathematicae 2022*, she established a function field analogue of the $K3$ surface setting result. The prize notes that ideas in this quartet of papers are expected to lead to further major results of this type. Finally, the prize recognizes the spectacular recent achievement of Dr. Tang in collaboration with Frank Calegari and Vesselin Dimitrov, namely, the resolution of the long-standing *unbounded coefficient conjecture* of Atkin and Swinnertin-Dyer that algebraic functions which are not invariant under any congruence subgroup of $SL_2(\mathcal{Z})$, must have unbounded denominators. The study of algebraic functions that are related to the moduli of elliptic integrals, stems from Ramanujan's own investigations and the plethora of beautiful modular identities that he discovered.