Preface to the special issue on ArasuFest

Alexander Pott¹ · Dean Crnković² · Ka Hin Leung³

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On the occasion of K.T. Arasu's 65th birthday, a conference “Sequences, Codes and Designs” took place at Kalamata (Greece), August 1–4, 2019. More than 30 talks covered Arasu's research interest in many different areas of discrete mathematics. The contributions in this volume are partially based on these talks, but one may also find papers from researchers who could not attend the conference.

The articles in this volume focus on topics in sequences, codes and designs, related to K.T. Arasu's influential work. All submissions have been thoroughly reviewed by at least two referees.

Arasu wrote his PhD thesis under the supervision of D.K. Ray-Chaudhuri about difference lists. Difference lists occur as homomorphic images of (putative) difference sets. The goal is to rule out the existence of such difference lists in order to rule out the existence of difference sets. In his thesis, Arasu developed a theory of such difference lists, and later on, he was able to rule out the existence of several difference sets whose existence has been undecided in the famous “Lander's tables” [12]. Let us mention [1,2,9] as some examples from this early scientific career of K.T. Arasu.

Since 1990, Arasu became interested in divisible and, as a special subcase, relative difference sets. It turned out that such divisible difference sets are closely related to projective planes admitting quasiregular automorphism groups, in particular semifields, as well as (vectorial) bent functions. Both these topics still attract many researchers! A paper that appeared in that period is the solution of the Waterloo problem [4], which deals with possible extensions of difference sets to relative difference sets.

✉ Alexander Pott
alexander.pott@ovgu.de

Dean Crnković
deanc@math.uniri.hr

Ka Hin Leung
matlkh@nus.edu.sg

¹ Otto von Guericke University, Magdeburg, Germany

² Department of Mathematics, University of Rijeka, 51000 Rijeka, Croatia

³ Department of Mathematics, National University of Singapore, 119076 Singapore, Singapore

We mentioned above that K.T. Arasu showed the nonexistence of several putative difference sets, in particular in the range of Lander's tables. In a short but very important paper [10], Arasu answered one of the open cases in those tables affirmatively. He also constructed some new Menon (nowadays called Hadamard) difference sets in groups where the existence was unknown before [3]. Both these results were an important impetus for the theory on difference sets since they showed that a lot more difference sets wait to be discovered. In the years prior to 1995, the research on difference sets focused mostly on the development of a nonexistence theory, and that changed dramatically at the end of the last century. Arasu's work played an important role here.

At the end of the century, the work of Arasu concentrated around group invariant weighing matrices. Again, he obtained important nonexistence, existence as well as classification results, see [8] as an example. The investigation of these types of combinatorial objects is more ambitious than the investigation of difference sets: one can still define designs out of such matrices (as in the difference set case), and one also has an automorphism group acting on the points of that designs, but the group is much smaller than in the difference set situation. One can still use number theoretic tools, in particular character theory, but the conditions that follow from the character equations are weaker than in the difference set case.

The theory of difference sets is quite often related to the theory of sequences. Therefore, it is no surprise that Arasu's list of publication also contains a remarkable list of papers about sequences. Let us mention just two of these. In [6], he constructed new examples of binary sequences with almost perfect autocorrelation properties. Another master piece is [5], a paper that contains constructions of several new families of sequences with ideal autocorrelation properties. In particular, the authors solve the Lin conjecture that has been open for almost 20 years. (This conjecture has been also proved, independently, in [11].)

In a similar way as difference sets are related to sequences, they are also quite naturally related to codes. A well-quoted result of Arasu on codes is [7], where the authors construct self-dual codes from certain weighing matrices.

After his retirement from academe, he had a small stint at US Air Force Research Lab and published a few papers on D -optimal designs. He then took a position at Riverside Research where he works on *Trusted and Resilient Systems* (TRS). Unpublished works with his team members there include work on new hashing algorithm and adversarial secure waveforms. His current work at TRS includes investigation of algebraic manipulation detection codes, frequency hopping sequences and unimodular sequences characterizing and extending those of Björck. His work on radar with colleagues at the Radar and Development Lab is in [13, 14]. The authors give a formal and satisfactory definition of "Doppler tolerance", filling a void in the radar literature. Moreover, they prove that two waveforms may not have zero cross-correlations for all delays and Dopplers, even when they are strictly orthogonal.

This quick tour through Arasu's scientific work gives an impression about his broad interest and his many influential results. What is also remarkable is the long list of Arasu's collaborators: that is a "whos's who" of researchers working in difference sets, sequences and codes. Arasu always finds links between these areas, and with all his enthusiasm he rushes and motivates his colleagues. Arasu continuously supports

and encourages young scientists. The many participants at the Arasu Fest in Kalamata showed his popularity both as a great scientist but also as a very good person.

The papers in this volume reflect the importance of K.T. Arasu's oeuvre much better than this preface. We encourage you to read the articles to admire the many facets of Arasu's mathematical work.

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References

1. Arasu, K.T.: (81, 16, 3) abelian difference sets do not exist. *J. Combin. Theory Ser. A* **43**, 350–353 (1986)
2. Arasu, K.T.: More missing entries in Landers table could be filled. *Arch. Math. (Basel)* **51**, 188–192 (1988)
3. Arasu, K.T., Davis, J.A., Jedwab, J., Sehgal, S.K.: New constructions of Menon difference sets. *J. Combin. Theory Ser. A* **64**, 329–336 (1993)
4. Arasu, K.T., Dillon, J.F., Jungnickel, D., Pott, A.: The solution of the Waterloo problem. *J. Combin. Theory Ser. A* **71**, 316–331 (1995)
5. Arasu, K.T., Dillon, J.F., Player, K.J.: Character sum factorizations yield sequences with ideal two-level autocorrelation. *IEEE Trans. Inform. Theory* **61**, 3276–3304 (2015)
6. Arasu, K.T., Ding, C., Helleseeth, T., Kumar, P.V., Martinsen, H.M.: Almost difference sets and their sequences with optimal autocorrelation. *IEEE Trans. Inform. Theory* **47**, 2934–2943 (2001)
7. Arasu, K.T., Gulliver, T.A.: Self-dual codes over $\mathbb{F}_p$ and weighing matrices. *IEEE Trans. Inform. Theory* **47**, 2051–2055 (2001)
8. Arasu, K.T., Leung, K.H., Ma, S.L., Nabavi, A., Ray-Chaudhuri, D.K.: Determination of all possible orders of weight 16 circulant weighing matrices. *Finite Fields Appl.* **12**, 498–538 (2006)
9. Arasu, K.T., and D. K. Ray-Chaudhuri, Divisible quotient lists and their multipliers, in *Proceedings of the sixteenth Southeastern international conference on combinatorics, graph theory and computing* (Boca Raton, Fla., 1985), 49, 321–338 (1985)
10. Arasu, K.T., Sehgal, S.K.: Some new difference sets. *J. Combin. Theory Ser. A* **69**, 170–172 (1995)
11. Hu, H., Shao, S., Gong, G., Helleseeth, T.: The proof of Lins conjecture via the decimation-Hadamard transform. *IEEE Trans. Inform. Theory* **60**, 5054–5064 (2014)
12. Lander, E.S.: *Symmetric designs: an algebraic approach*. London Mathematical Society Lecture Note Series. Cambridge University Press, Cambridge (1983)
13. Setlur, P., Arasu, K.T.: Non-orthogonality in mimo radar: A fractional fourier approach. *IEEE Int. Radar Conf. (RADAR)* **2020**, 928–933 (2020)
14. Setlur, P., Hollon, J., Arasu, K.T., Rangaswamy, M.: On a formal measure of doppler tolerance. *IEEE Radar Conf. (RadarConf)* **2017**, 1751–1756 (2017)

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