The Magic Square in Thiruvananthapuram

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Abstract

This paper examines a 3x3 Magic Square recently identified by the author, engraved on the ceiling of the Ārāttu Mandapam in Shanghumukham, Thiruvananthapuram. This structure was built during the reign of Mārthānda Varma (1729–1758 CE), the founding monarch of the Kingdom of Trāvancōre. Historically, Magic Squares functioned as mystic diagrams in worship, meditation, and rituals, frequently appearing in religious manuscripts and on monuments. Their evolution is a compelling narrative of intellectual curiosity, cultural adaptation, and cross-civilizational exchange. From their ancient origins as talismans and tools of divination to their modern study in combinatorics and number theory, Magic Squares remain a source of fascination.

Kerala's distinguished mathematical heritage, exemplified by the Kerala School of Astronomy and Mathematics, provides a fertile context for such numerical explorations. This is further evidenced by widespread cultural practices, such as the use of yantras in temple architecture and the creation of geometrically precise Kalams in rituals, which demonstrate a profound cultural engagement with numerical and geometric harmony. Despite this rich backdrop, the Magic Square at Ārāttu Mandapam currently stands as the only known example of its kind discovered in Kerala.

Keywords: Ārāttu Mandapam; Chakra Mandapam; Magic Square; Mārthānda Varma; Shanghumukham; Sree Padmanābhaswāmy Temple; Thiruvananthapuram; Trāvancōre, Varkala.

1. Introduction

A Magic Square represents a fascinating intersection of mathematics, art, and cultural belief, captivating human intellect for millennia. Formally, a Magic Square is an $n \times n$ array of numbers in which each of the n^2 elements appears precisely once. A defining characteristic is that the sum of the numbers in each row, each column, and both main diagonals is identical — a constant value known as the magic constant. For a square to be considered normal, it must use distinct positive integers ranging from 1 to n^2. The smallest non-trivial example of a Magic Square is of order 3; a square of order 2 cannot be constructed under these rules.

The universal appeal of Magic Squares stems from their inherent numerical harmony and the seemingly mystical regularity they embody. In diverse civilisations, these arrays have been regarded not merely as mathematical curiosities but often as objects imbued with mystical or

recreational significance. Engaging with Magic Squares stimulates critical thinking, logical reasoning, and pattern recognition, making them valuable tools for mental development.

The study of Magic Squares illustrates a compelling evolution in mathematical inquiry. Initially, the focus was on the simple—yet profound—property of constant sums. As understanding deepened, mathematicians began to categorise, enumerate, and generalise these structures. This progression — from empirical discovery and often mystical application to systematic mathematical theory — reflects a maturation of the field within various cultures. The fact that completely general methods for producing all Magic Squares for every order do not exist underscores that, despite centuries of rigorous investigation, the field remains open and challenging. This ongoing complexity and enduring appeal highlight the profound nature of these numerical arrangements

The history of magic squares is a rich tapestry woven from independent discoveries and cross-cultural exchanges across continents. This is where the true relevance of the magic square discovered on the ceiling of the Ārāttu Mandapam, located at Shanghumugham Beach in Thiruvananthapuram, comes into focus. This historic stone pavilion is central to the ceremonial Ārāttu bath of Lord Sree Padmanābhaswāmy — the revered deity of the well-known temple bearing the same name.

2. Rendering

The magic square in Thiruvananthapuram is of order 3 × 3, meaning it has three rows and three columns. The square is divided into nine blocks, one for each numeral. No digit is used more than once, and all are single-digit numbers. Thus, the blocks containing the numerals from 1 to 9, without duplication, are arranged in a 3 × 3 grid. The arrangement begins with 4 in the top-left corner, followed by 9, and ends with 2 across the first row. The second row begins with 3, followed by 5, and ends with 7. The third (and final) row starts with 8, followed by 1, and ends with 6. All the numerals are depicted using the Tamil script, which was prevalent at that time. Whether you add the numbers row-wise, column-wise, or diagonally, the total is always 15.

3 Rows:

- 4 + 9 + 2 = 15.
- 3 + 5 + 7 = 15.
- 8 + 1 + 6 = 15.

3 Columns:

- 4 + 3 + 8 = 15.
- 9 + 5 + 1 = 15.
- 2 + 7 + 6 = 15.

2 Diagonals:

- 4 + 5 + 6 = 15.
- 8 + 5 + 2 = 15.

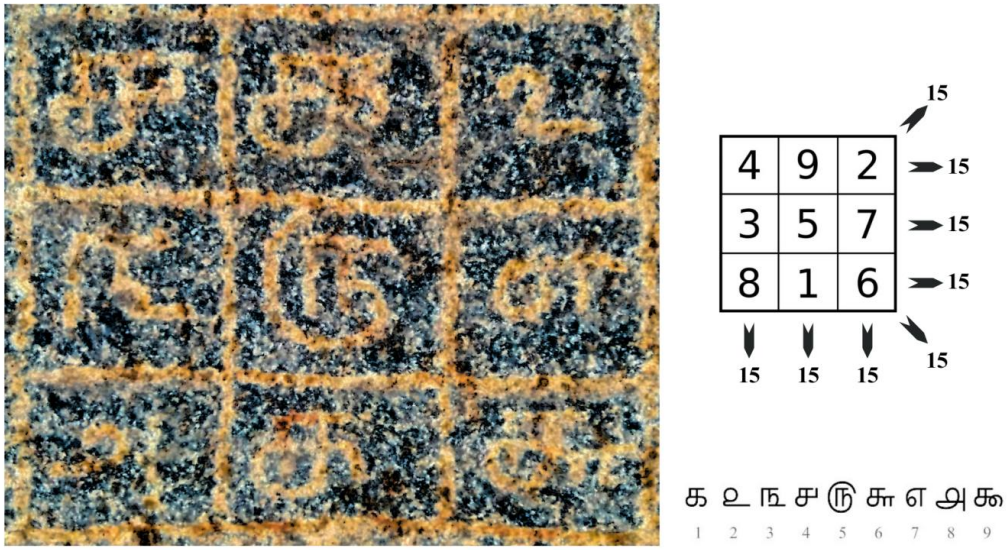


Figure 1: *Photographic image of the Magic Square and its rendering.*

3. Antiquity

A record preserved at the Kerala State Archives Department confirms that the mandapam [1], where the Magic Square is engraved, was commissioned by Mārthānda Varma, the Trāvancōre monarch. This structure was built to facilitate the ceremonial *ārāttu* bath of Sree Padmanābhaswāmy during the biannual festivals. Ōla [2] 709 in Mathilakam Churuna [3] 866, dated 933 in the Kollam Era [4], specifies that the granite for building this Chakra Mandapam [5] was brought from Varkala, a place approximately 45 km northwest of Shanghumugham, the beach where the mandapam is located. This document accurately provides the year in which this mandapam was constructed. This mandapam has retained its original glory without any additions or alterations, indicating that the engraving must have been done during its initial construction. The inscribed numerals, which are in Tamil script from the same period, further corroborate this.

Anizham Thirunāl Mārthānda Varma was the visionary and founding monarch of the southern Indian Kingdom of Trāvancōre, reigning from 1729 to 1758 CE. He is widely considered one of the most significant figures in Kerala's history, transforming a small principality (Venād) into a powerful and prosperous state. His reign was marked by significant civil construction activities, including:

- The Navarāthri Mandapam and Thævārakkettu (Saraswathy Temple): Constructed in granite in 1744 CE, these replaced earlier wooden structures inside the Padmanābhapuram Palace Complex.

- The reconstruction of the older mud fort around Padmanābhapuram Palace into a granite fort in 1745 CE, with walls reportedly 30 feet high. This fort complex included various gates and bastions.
- Initiation of the construction of a fort around the Sree Padmanābhaswāmy Temple in Thiruvananthapuram in 1747 CE.

His deep devotion to Sree Padmanābhaswāmy also led to extensive construction and renovation work at the Sree Padmanābhaswāmy Temple itself. He oversaw the reconstruction of the main deity, which had been destroyed in a fire during a previous reign. He also built the Oṭṭakkal Mandapam [6] and the Shēvælippura [7] within the temple complex, and the construction of the massive Kshethra Gōpuram [8] also began during his reign. The Ārāttu Mandapam, where the Magic Square is engraved, is just one noticeable feat among this impressive list of ongoing civil construction activities. Mārthānda Varma's civil construction activities were not merely about aesthetics; they were integral to his state-building efforts, aiming to consolidate power, enhance security, improve the economy, and reinforce the spiritual foundation of his rule.

4. The Ārāttu Ceremony: Purpose and Significance

The Ārāttu Mandapam is inextricably linked to the Ārāttu ritual, a ceremonial bath that constitutes a crucial bi-annual event. This sacred bathing of the deity is primarily conducted at the conclusion of the Painkuni[9] and Alpashi [10] festivals associated with the Sree Padmanābhaswāmy Temple. The ceremony involves a grand procession that commences at the Sree Padmanābhaswāmy Temple and proceeds majestically towards Shanghumugham Beach. This procession is notably led by the head of the Travancore Royal Family, sword in hand, accompanied by a majestic retinue including caparisoned elephants, mounted police, and columns of armed police. This regal and spiritual spectacle is a unique and historic sight, attracting thousands of devotees who line the streets to witness the event.

The procession culminates at the Ārāttu Mandapam on Shanghumugham Beach. Here, the Irakki Pooja [11] (concluding rituals) for the idols is performed, followed by the essential holy bath in the sea. The mandapam serves as the sacred space for these final and most significant rituals before the idols are immersed, making it an indispensable component of the entire ceremony. The very existence and continued use of the mandapam highlight the enduring nature of these religious practices and the Trāvancōre royal family's unwavering dedication to their patron deity. Its location directly on the beach is not a matter of chance but a functional imperative for the sea bath ritual, a core element of the Ārāttu that cannot be replicated elsewhere. The continued leadership of the procession by the royal family, culminating at this ancient structure, reinforces their traditional role as the custodians of religious rites and their symbolic connection to the divine. This demonstrates the persistent relevance and vitality of these ancient traditions in contemporary times, even after the formal dissolution of the royal

family's political power. The mandapam thus stands as a physical anchor for a living heritage, a tangible testament to the resilience of cultural and religious practices.

5. Psychology and Significance of the Magic Square's Placement

The depiction of a Magic Square in a public place, especially within a sacred or royal context like the *Ārāttu Mandapam* in Trāvancōre, reflects a deep-rooted psychology that intertwines mathematics, mysticism, order, and cosmic harmony.

5. 1. Symbol of Divine Order and Cosmic Harmony

5.1.1 Perfection and Balance: Magic Squares, by their very definition, represent perfect balance and order. Every row, column, and diagonal sums to the same "magic constant." This mathematical regularity was often seen as a reflection of divine order in the universe. In a religious context, this resonates with the concept of *ṛta* (cosmic order) and the harmonious functioning of the cosmos.

5.1.2 Connection to Deities and Planets: Historically, in many cultures, including India, Magic Squares were associated with planets, deities, and astrological influences. Each number or configuration might be believed to carry specific energies or represent divine attributes. Placing such a symbol in a *mandapam* used for the *ārāttu* of Sree Padmanābhaswāmy would reinforce the belief in divine presence and blessings, and perhaps even invoke specific cosmic energies beneficial for the ritual.

5.1.3 A representation of the Universal Truth: For many ancient civilisations, mathematics was not just a tool but a way to understand the underlying structure of reality. A Magic Square, with its inherent patterns and consistent sums, could be seen as a microcosm of universal laws, demonstrating that even in seemingly complex arrangements, there is an underlying, divine truth.

5.2. Protective Amulet and Source of Good Fortune

5.2.1. Apotropaic Function: Throughout history, Magic Squares were widely believed to possess apotropaic (evil-averting) qualities. Engraving them on buildings, especially those with religious significance or royal association, served as a protective charm against evil spirits, negative influences, or misfortunes. It's a psychological act of seeking spiritual safeguarding for the space, the rituals performed there, and the people participating.

5.2.2. Bringing Prosperity and Blessings: Beyond protection, Magic Squares were often thought to attract good fortune, prosperity, and blessings. For a monarch like Mārthānda Varma, who was consolidating his kingdom and seeking stability, such a symbol could be seen as invoking divine favour for his rule and his people.

5. 3. Demonstration of Wisdom and Knowledge

5.3.1. Intellectual Sophistication: The creation and understanding of Magic Squares required mathematical knowledge and intellectual prowess. Their public display, especially in a prominent location, subtly communicated the wisdom and sophistication of the ruler and the court. It suggested that the kingdom was governed by enlightened minds who understood the deeper workings of the universe.

5.3.2. Symbol of Sacred Geometry: Magic Squares fall under the broader category of sacred geometry. Their presence signifies an awareness and appreciation of these profound mathematical principles, which were often considered divine in origin and imbued with spiritual power.

5. 4. Enduring Legacy and Timelessness

5.4.1. Monumental and Permanent: Engraving a Magic Square in stone, as opposed to drawing it on perishable materials, signals an intent for permanence. It's a statement that these principles are timeless and eternally relevant. For a ruler, it's a way to stamp his legacy with something perceived as eternal and wise.

5.4.2. Fascination and Intrigue: Even for those who don't fully understand the mathematical intricacies, a Magic Square is inherently intriguing. Its symmetrical patterns and the "magical" property of its sums can evoke a sense of wonder and curiosity. This can draw people in and make them ponder the deeper meanings, contributing to the mystique of the place.

5. 5. Reinforcement of Royal and Religious Authority:

5.5.1. Divine Sanction for Rule: In the context of Mārthānda Varma's reign, particularly after the *Thrippadidānam* (dedication of the kingdom to Padmanābhaswāmy), placing a Magic Square in a *mandapam* used for temple rituals further linked the monarch's authority to divine will. It suggested that his rule was harmonious, orderly, and divinely blessed, reinforcing his legitimacy in the eyes of the populace.

5.5.2. Cultural Continuity: Magic Squares have a long history in India. Their inclusion in new constructions connects the present rule to ancient traditions and wisdom, providing a sense of continuity and stability.

6. Magic Squares in Indian Mathematics and Cultural Practices

The Indian tradition of Magic Squares, known as Bhadraganita [12], is distinguished by its profound mathematical rigour and its deep integration into the cultural and spiritual fabric of society. This dual role underscores a holistic approach to knowledge, where numerical patterns held both intellectual and symbolic significance.

6. 1. Classical Era Contributions

In the classical era, Varāhamihira (c. 550 CE), a prominent astronomer and mathematician, significantly advanced the study of Magic Squares through his influential work, the Brihatsamhita [13]. He detailed *Sarvatobhadra* squares, a term meaning "auspicious in all directions," which were designed to maintain consistent sums not only across rows, columns, and main diagonals but also in specific sub-configurations such as central quadrangles or corner cells. A notable application of these squares was in Gandhayukti, the art of perfumery, where they were used to precisely quantify ingredient proportions, demonstrating an early practical application of these mathematical constructs rooted in a belief in their inherent balance.

6. 2. Medieval Advancements and Systematisation

The medieval period witnessed a systematic development of Magic Square theory in India. Ṭhakkura Pherū (c. 1300 CE) [14] introduced a comprehensive classification system for n x n Magic Squares, categorising them into three types: *Samagarbha* (doubly even, where n is a multiple of 4), *Vismagarbha* (singly even, where n is an even number not a multiple of 4), and *Visama* (odd, where n is an odd number). He also provided explicit methods for constructing Samagarbha and Visama Squares. For instance, his approach for 8x8 squares involved tiling four 4x4 squares using a technique known as *Turagagati*, which resembles a knight's tour, highlighting the modularity of Indian mathematical approaches.

7. Development and Cross-Cultural Exchange

The historical trajectory of magic squares reveals a pattern of both invention and significant cultural diffusion, with distinct origins evident in India (with Nagarajuna's [15] early 4x4 squares). There is considerable evidence of knowledge transfer, such as the posited acquisition of the concept by Arabic scholars from India, mirroring their adoption of decimal arithmetic, particularly following the 7th-century Arab Jihad, which facilitated the absorption of Indian mathematics and astronomy. Indian methods, such as the *alpasiruti* method for odd squares, were documented in Europe by the late 17th century (e.g., by La Loubère, who learned it via a French doctor in Surat), illustrating India's substantial impact on combinatorial mathematics.

The history of magic squares is not a simple linear progression but a complex interplay of parallel evolution and cultural adaptation. The initial concept likely arose independently in different regions due to a universal human curiosity about numbers and patterns. However, their subsequent development and dissemination were profoundly shaped by cultural interactions and trade routes. The "murky" historical record and the necessity for "re-discovery" in Europe indicate that knowledge transfer was often incomplete or indirect, leading to fragmented understanding and the loss of earlier insights. The varied cultural interpretations - such as magic squares being viewed as "occult objects" in Renaissance Europe versus their integration into religious rituals and daily life in India - underscore the diverse ways societies engaged with these

numerical constructs. This complex historical narrative reflects the multifaceted relationship humans have cultivated with numbers and patterns across civilisations.

Table 1: *Key historical milestones of magic squares across civilisations.*

Era/Date	Civilisation/ Region	Key Development /Figure	Significance	Example (if applicable)
1st Century CE	India	Nagarajuna	First known 4x4 magic square in India	4x4 Square
c. 550 CE	India	Varāhamihira	Described '*Sarvatobhadra*' squares; used in perfumery	*Sarvatobhadra* squares
8th-9th Century CE	Middle East	Arabic scholars	Early knowledge, acquired from India; used in astrology	-
c. 983 CE	Middle East	Ikhwan al-Saf' Ras'il	First magic squares of order 5 and 6 documented in encyclopedia [16]	5x5, 6x6 Squares
11th-12th Century CE	India	Jaina mathematicians	Inscriptions of pan-diagonal 'Jaina squares'; used as talismans/educational aids [17]	4x4 Jaina Square (Khajuraho)
c. 1200 CE	Middle East	Al-Buni[18]	Attributed mystical properties; used in astrological calculations	-
c. 1300 CE	India	Thakkura Pherū	Classified magic squares (*Samagarbha*, *Vismagarbha*, *Visama*); *Turagagati* method	8x8 squares via *Turagagati*
c. 1300 CE	Europe (Byzantium)	Manuel Moschopoulos	Earliest Greek text, derived from Arabic/Persian sources [19]	-
14th Century CE	India	Nārāyana Pandita	Most comprehensive treatment ('*Bhadra-ganita*'); refined classifications; *alpasiruti*, *Samputavidhi* methods	Pan-diagonal squares, odd-order squares
1514 CE	Europe	Albrecht Dürer	First occurrence in Western art (etching Melencolia I) [20]; 4x4 grid; sum 34	Dürer's 4x4 Magic Square
Late 17th Century CE	Europe	De La Loubère	Documented Indian *alpasiruti* method, showing global influence [21]	-
20th Century CE	India	Srinivasa Ramanujan	Explored magic squares in notebooks; unique geometric construction methods [22]	Personalised magic squares
20th-21st Century CE	India (Kerala)	Neeradha. C. K., Madhukar Mallayya	Continued academic research, including 'strongly magic squares' [23]	Personalised magic squares, strongly magic squares

Nārāyana Pandita, a 14th century mathematician, offered what is considered the most comprehensive treatment of Magic Squares in his Ganitakaumudi (c. 1356 CE). He refined Pherū's classifications and placed particular emphasis on pan-diagonal squares, where even broken diagonals sum to the magic constant. Nārāyana's advanced construction techniques included the *alpasiruti* method for odd-order squares, which involved placing numbers along diagonals and adjusting for occupied cells. This technique later found its way to Europe, demonstrating India's global influence on combinatorial mathematics. Another significant method was the *Samputavidhi*, or 'folding method,' for odd-order squares, which conceptually resembles the combination of mutually orthogonal Latin Squares, showcasing a sophisticated understanding of combinatorial structures. Nārāyana also delved into combinatorial questions, estimating the number of possible 4x4 pan-diagonal squares with entries 1 to 16 to be 384, a figure later confirmed by modern mathematicians.

8. Conclusion

In essence, the psychology behind placing a Magic Square in a public, sacred space like the *Ārāttu Mandapam* is a blend of spiritual aspiration, protective intention, intellectual display, and the symbolic reinforcement of power and order. It's a testament to how ancient cultures integrated mathematics and mysticism to create meaningful symbols for their society. The presence of this square reaffirms the enduring legacy of the Kerala School of Astronomy and Mathematics, placing a local object of worship and protection within the broader history of Indian mathematical innovation and its significant contribution to global combinatorial thought.

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Acknowledgments are due to my nephew, Mr. Ajil Benny Kuthiravelil [24], for first spotting and bringing the intriguing Thiruvananthapuram Magic Square to my attention. His keen observation of the art and architecture of the *Ārāttu Mandapam* during our travels to Shanghumugham provided a unique and valuable focus for this research, enabling us to explore the confluence of recreational mathematics and local folklore within the cultural context of Thiruvananthapuram.

References

[1] *Mandapam*s are almost always characterised by a series of pillars that support the roof. These pillars are often intricately carved with deities, mythological scenes, floral patterns, and various other decorative motifs, showcasing exquisite craftsmanship.

[2] *Ōla* is the dried not so mature leaves of the Talipot palm (Corypha umbraculifera) and the Palmyra palm (Borassus flabellifer), which are used for writing, using a sharp metal stylus called *nārāyam*.

[3] *Mathilakam* means *inside the wall. Churuna* refers to a rolled bundle of palm leaf manuscripts (*ola*s) from the Mathilakam Archives, which served as the central archive of the erstwhile Trāvancōre kingdom.

[4] A purely solar calendar which started reckoning in 825 CE. So 933 KE corresponds to 1758 CE.

[5] *Chakra Mandapam is the actual name of the mandapam as quoted in the Mathilakam Churuna. Chakra is a wheel (Sudarshana Chakram), one of the two major attributes of Vishnu.*

[6] Means *monolithic* - the famous *mandapam* in the Sree Padmanābhaswāmy Temple.

[7] *Shēvæli* is a temple ritual consisting of a ceremonial procession where food offerings are made to the various deities and their retinue within the temple complex. *Shēvælippura* refers to the architectural structure or corridor within the temple complex where this *Sheveli* ritual is performed.

[8] *Kshethra Gōpuram is the temple tower.*

[9] *Painkuni* is the Malayalam name for the festival that occurs in the month of *Meenam*, which broadly corresponds to *Panguni*, the last month of the Tamil calendar.

[10] *Alpashi* is the Malayalam name for the festival that occurs in the month of *Thulām*, which broadly corresponds to *Aippasi*, the seventh month of the Tamil calendar.

[11] *Irakki Pooja* is the *pooja* done after placing down the three palanquins having on them the *Utsava Mūrti*s (Processional Idols), carried by priests on their shoulders.

[12] *Bhadraganita* is the term for the construction of magical squares or diagrams.

[13] Varaha Mihira, Translators: Panditbhushan V. Subrahmanya Shastri, B.A. and Vidwan M. Ramkrishna Bhat, Printed by: V.B. Soobbiah and Sons, M.B.D. Electronic Printing Works, Bangalore, 1946.

[14] Ṭhakkura Pherū, Gaṇitasārakaumudi: The Moonlight of the Essence of Mathematics, edited with Introduction, Translation and Mathematical Commentary by SaKHya, Manohar, New Delhi, 2009.

[15] Nagarjuna, Kaksha Puti Grantha Siddha Nagarjuna Ed., Guracharya Baala Krisnacharya Bukkebag, Nagesa Govinda Bhatta Rama Tattva Prakshana, 1897. Available digitally at Internet Archives, accessed on 31/10/2025. https://archive.org/details/kakshaputigranthasiddhanagarjunaed.guracharyabaalakrisnacharyabukkebagnagesagovi/page/n155/mode/2up

[16] Ikhwān al-Safā' (Brethren of Purity). Stanford Encyclopedia of Philosophy. PDF preview available at https://leibniz.stanford.edu/friends/preview/ikhwan-al-safa/ (accessed 01/11/2025).

[17] Stephan Berendonk, Proving the loneliness of the Khajuraho square, *The Mathematical Gazette*, Vol. 99, No. 544 (March 2015), pp. 33-39, The Mathematical Association, London.

[18] Ahmad al-Buni, Shams al-Ma'arif (The Book of the Sun of Gnosis), manuscript available at https://en.wikipedia.org/wiki/Shams_al-Ma%27arif#/media/File:Khalili_Collection_Islamic_Art_mss_0556_fol_173b-174a.jpg (accessed 01/11/2025).

[19] Treatise on Magic Squares. https://www.encyclopedia.com/science/dictionaries-thesauruses-pictures-and-press-releases/moschopoulos-manuel#:~:text=This%20kind%20of%20exercise%20occurs,scholar%20having%20been%20in%20Persia. (accessed on 01/11/2025).

[20] A large 1514 engraving by the German Renaissance artist Albrecht Dürer. Behind the figure is a structure with an embedded magic square. https://en.wikipedia.org/wiki/Melencolia_I (accessed on 01/11/2025).

[21] De la Loubère, A new historical relation of the kingdom of Siam, The problem of the magical square according to the Indians (chapter), page 228, Du Royaume de Siam, 1693. Digitally available at https://digital.library.cornell.edu/catalog/sea130 (accessed on 01/10/2025).

[22] a. George P. H. Styan, An introduction to Ramanujan's magic squares, the International Workshop and Conference on Combinatorial Matrix Theory and Generalized Inverses of Matrices, Manipal University, Manipal (Karnataka), India, 2–11 January 2012. https://www.math.mcgill.ca/styan/Beamer3-18jan12-opt.pdf (accessed on 01/11/2025).

b. Bruce C. Berndt, Ramanujan's Notebooks, *Mathematics Magazine*, Vol. 51, No. 3 (May, 1978), pp. 147-164, Mathematical Association of America, Taylor & Francis, Ltd. https://www.jstor.org/stable/2689995 (accessed on 01/11/2025).

[23] Neeradha. C. K, Dr. V. Madhukar Mallayya, General Properties of Strongly Magic Squares, *International Journal of Scientific and Innovative Mathematical Research (IJSIMR)*, Volume 4, Issue 8, August 2016, PP 7-14, available at https://www.arcjournals.org/pdfs/ijsimr/v4-i8/4.pdf (accessed on 01/11/2025).

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