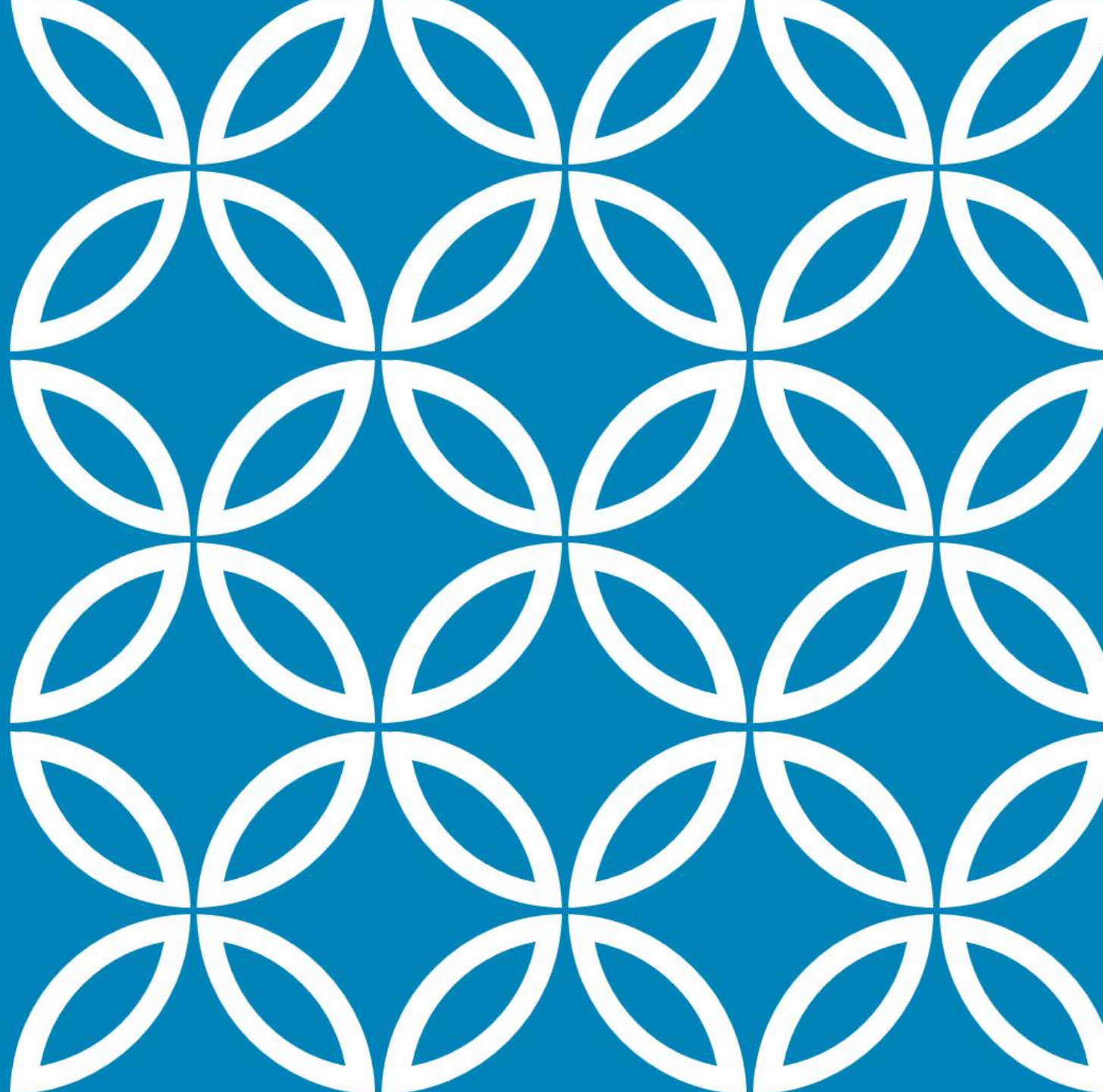
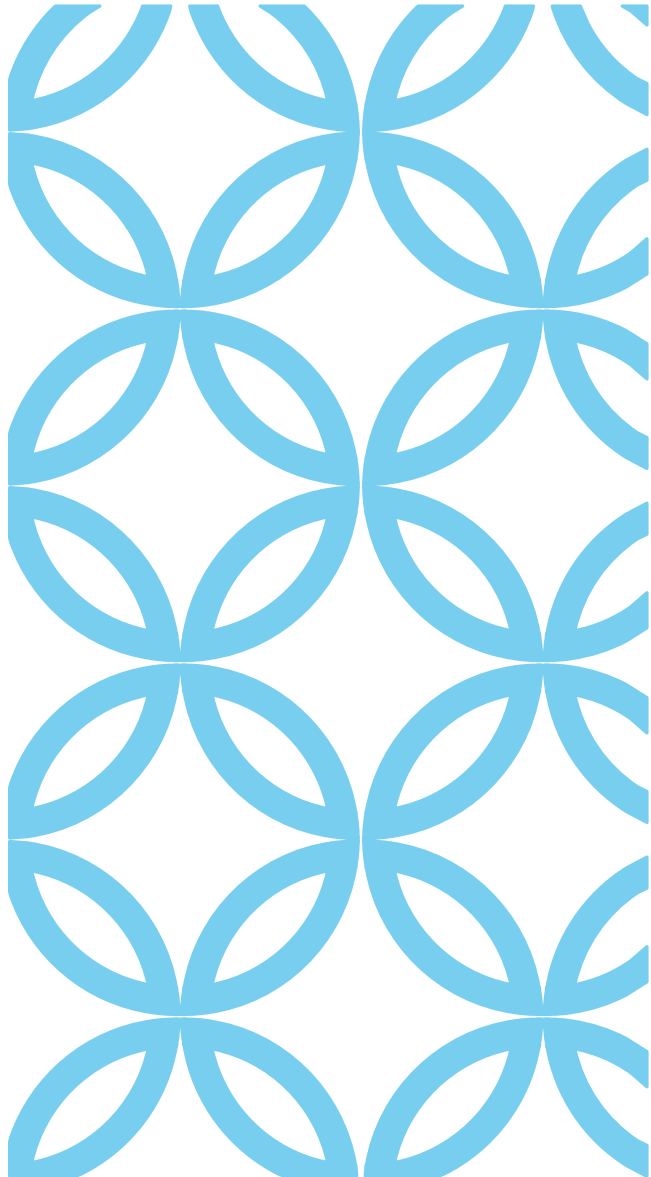


SRINIVASA RAMANUJAN

Aleksandra Kuzko
Joanna Lewandowska
Beata Pawlikowska
wydział MiNI
rok 2018/19
semestr 5
Krótki Kurs Historii Matematyki





ur. 22 grudnia 1887r. w Erode

zm. 26 kwietnia 1920

syn braminów

matematyk - samouk



KIM BYŁ RAMANUJAN?

WCZESNE ŻYCIE

7 lat - stypendium w szkole podstawowej w Kumbakonam

15 lat – „Krótki opis elementarnych wyników z czystej matematyki” G. S. Carra – pierwszy podręcznik

16 lat – stypendium w szkole średniej w Kumbakonam

21 lat – założył rodzinę i rozpoczął pracę z Dewanem Behandurem R. Ramachandrq Rao

25 lat – list do matematyków angielskich

A MISSING BOY.

TO THE EDITOR OF THE "HINDU."

SIR,—Kindly insert the following in your widely circulated journal:

"A Brahmin boy of the Vaishnava (Thengalai) sect, named Ramanujam, of fair complexion and aged about 18 years was till recently a student of the Kumbakonam College. He left his home on some misunderstanding. His guardian is very solicitous about the boy's returning home. He stayed at Rajahmundry for about a month, and was last seen there some five days back. Those who happen to see him are kindly requested to persuade him to return home, and to communicate his whereabouts to.

J. SEENIVASA RAGHAVA AYANGAR,
18, Sarangapani Sannidhi Street,
Kumbakonam.

September 2.

A SYNOPSIS
OF
ELEMENTARY RESULTS
IN
PURE MATHEMATICS:

CONTAINING
PROPOSITIONS, FORMULÆ, AND METHODS OF ANALYSIS,
WITH
ABRIDGED DEMONSTRATIONS.

SUPPLEMENTED BY AN INDEX TO THE PAPERS ON PURE MATHEMATICS WHICH ARE TO BE FOUND IN THE PRINCIPAL JOURNALS AND TRANSACTIONS OF LEARNED SOCIETIES, BOTH ENGLISH AND FOREIGN, OF THE PRESENT CENTURY.

BY
G. S. CARR, M.A.



LONDON:
FRANCIS HODGSON, 89 FARRINGDON STREET, E.C.
CAMBRIDGE: MACMILLAN & BOWES.

1886.

(All rights reserved.)

ERRATA.

Art. No.	Line	for	read
36	Line 1.	= 2	= 1.
96	= 3.	= x	= x^2 .
98	= 8.	numbers 1, 1, 1	= 1, x , x^2 .
101	= 1.	denominator $x-1$	= $x-1$.
107	= 1.	taken	taken as at a line.
109	= 2.	(100)	(100).
111	= 1, 2.	= 2	= 4.
111	= 3.	(-1) ⁿ	(-1) ⁿ .
113	= 2, 5, 7.	= 6	= 36.
113	= 8.	= 4	= 16.
113	= 9.	204, 410	102, 206.
113	= 10.	410	206.
116	= 4.	$\frac{16.8.8}{1.2.2}$	7.8.8.16.
116	= 5.	$(x+1)^2$	$(x+1)^2$ Notation of (9).
116	= 6.	x_{n-1} in numerator	x_n .
119	= 4.	(142)	(144).
120	= 6.	$(x+x^2)^2$	$2(x+x^2)^2$.
121	= 4.	(1)	square of (1).
127	= 11.	$x^2=1$	$x^2=-1$.
128	= 8.	(x^2-4x+1) on left side	(x^2-4x+9) .
129	= 11.	(124)	(126).
131	= 6.	(20)	(20).
132	= 4.	(207)	(210).
134	= 8.	(1)	(1).
135	= 11.	$x+2$	$x+1$.
135	= 14.	$(x-1)$	$(x-2)$.
135	= 3.	$x=1$	$x=4$.
136	= 2.	$x=1$	$x=1$.
136	= 4.	$H(x, x-1)$	$H(x, x-1)$.
136	= 2.	$H(x+1, x-1)$	$H(x, x)$.
136	= 12.	x	x .
136	= 12.	x^2/x^2 last line but one	$0, 0, 0$.
135	= 3.	$\left(\frac{x+1}{2}\right)^2$	$\left(\frac{x+1}{2}\right)^2$.
161	= 7.	1020	1020.
161	= 6.	$x=2$	$x=1$.
164	= 4.	applying Democritus' rule	(1).
177	= 3.	x^2	Transpose F and f .
184	= 3.	x	x .
184	= 1.	x	x .
184	= 3.	$x=x$	$x=x$.
194	= (11, 12)	(11, 12)	(3, 10, 1).
194	= (10)	(10)	(100).

Article 112 should be as follows:—

$$\frac{1}{1+2\sqrt{3}-\sqrt{2}} = \frac{1+2\sqrt{3}+\sqrt{2}}{(1+2\sqrt{3}-\sqrt{2})(1+2\sqrt{3}+\sqrt{2})} = \frac{1+2\sqrt{3}+\sqrt{2}}{11+4\sqrt{2}}$$



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1	1
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LIST

Szanowny Panie,

Pozwala sobie do Pana pisać urzędnik w dziale księgowości biura władz portu w Madrasie, mający roczną pensję w wysokości 20 funtów. Mam 23 lata. Nie studiowałem na uniwersytecie, ale ukończyłem naukę szkolną. Po ukończeniu szkoły poświęciłem się badaniom matematycznym. Nie poszedłem drogą wyznaczoną przez kursy uniwersyteckie, ale podążam własną ścieżką. Zbadałem dokładnie ogólne zagadnienie szeregów rozbieżnych i otrzymałem wyniki uznawane za „niespodziewane” przez lokalnych matematyków...

Chciałbym prosić Pana o recenzję mojej pracy. Jeśli uważa Pan, że jest w niej coś wartościowego, być może mógłby Pan opublikować moje wyniki, ponieważ ja nie mam na to środków. Nie podałem szczegółów obliczeń ani wzorów, których używam, ale opisałem dokładnie kolejne kroki rozumowania. Ze względu na mój brak doświadczenia będę bardzo wdzięczny za rady. Proszę o wybaczenie, jeśli moja prośba powoduje jakieś niedogodności.

Z poważaniem,

S. Ramanujan

In page 36 it is stated that "the no of prime nos less than $x = \int_2^x \frac{dx}{\log x} + P(x)$ where the precise order of $P(x)$ has not yet been determined."

The precise order itself is not sufficient to find the value of $P(x)$. Even if it is known that $\frac{P(x)}{P(x)} = 1$ when x becomes infinite, $P(x)$ being a known function of x , $P(x)$ cannot be supposed to have been found with sufficient accuracy; for example $(x + \frac{7}{\log x})/x = 1$ when x becomes infinite, yet the difference between $x + \frac{7}{\log x}$ and x is very great.

From the forms of $P(x)$ given in page 53, viz.

$O\left\{\frac{7}{(\log x)^2}\right\}$, $O(xe^{-a\sqrt{\log x}})$, $O(\sqrt{x})$, &c it appears that from particular numerical values the forms have been guessed.

Even in regular functions it is difficult to have an idea of the form from the numerical values. In such a complicated function as $P(x)$ it is difficult to have an idea even for large values of $\log x$; for example even if we give bellion for x , $P(x)$ is very difficult to be found.

I have observed that $P(e^{37x})$ is of such a nature that its value is very small when x lies between 0 and 3 (its value is less than a few hundreds when $x = 3$) and rapidly increases when x is greater than 3.

I have found a function which exactly represents the no. of prime nos less than x , 'exactly' in the sense that the difference between the function and the actual no. of primes is generally 0 or some small finite value even when x becomes infinite.

SI

I have got theorems on divergent series, theorems to calculate the convergent values corresponding to the divergent series viz.

$$1 - 2 + 3 - 4 + \dots = \frac{1}{2}$$

$$1 - 4 + 12 - 32 + \dots = .576 \dots$$

$$1 + 2 + 3 + 4 + \dots = -\frac{1}{12}$$

$$1^3 + 2^3 + 3^3 + \dots = \frac{1}{120}$$

Theorems to calculate such values for any given series (say $1 - 1^r + 2^r - 3^r + 4^r - 5^r + \dots$), and the meaning of such values.

I have also written statements clearing dealt with such questions "When to use, where to use, and how to use such values," where do they fail and where do they not?"

I have also given meanings to the fractional and negative no of terms in a series as well as in a product and I have got theorems to calculate such values exactly and approximately. Many wonderful results have been got from such theorems; e.g.

$$\frac{1}{n} + \left(\frac{1}{2}\right)^2 \frac{1}{n+1} + \left(\frac{1 \cdot 3}{2 \cdot 4}\right)^2 \frac{1}{n+2} + \left(\frac{1 \cdot 3 \cdot 5}{2 \cdot 4 \cdot 6}\right)^2 \frac{1}{n+3} + \dots$$

$$= \left\{ \frac{\Gamma(n)}{\Gamma(n+\frac{1}{2})} \right\}^2 \left\{ 1 + \left(\frac{1}{2}\right)^2 + \left(\frac{1 \cdot 3}{2 \cdot 4}\right)^2 + \dots \text{ to } n \text{ terms} \right\}$$

It is even possible to find the true value in the cases in which the use of divergent series fails by finding the diffce between the true and apparent values

I have got the functions in the form of infinite series and have expressed it in two ways.

- (1) In terms of Bernoullian numbers. From this we can easily calculate the no. of prime nos. up to 100 millions. with generally no error and in some cases with an error of 1 or 2.
- (2) As a definite integral from which we can calculate for all values.

II

I have also got expressions to find the actual no of prime nos of the form $An + B$, which are less than any given number however large. The difference between the no of prime nos of the form $4n-1$ and which are less than x and those of the form $4n+1$, less than x is infinite when x becomes infinite.

Theorems connected with the calculations of the difference when x is a given number and similar calculations have also been got.

III

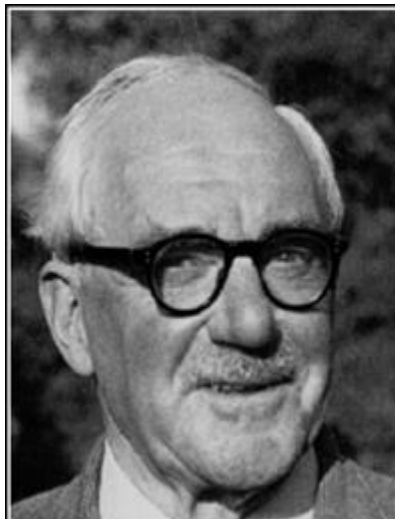
I have found out expressions for finding not only irregularly increasing functions but also irregular functions without increase (e.g. the no. of divisors of natural nos.) not merely the order but the exact form. The following are a few examples from my theorems.

- (1) The nos of the form $2^p \cdot 3^q$ less than $n = \frac{1}{2} \frac{\log 2n \log 3n}{\log 2 \log 3}$ where p and q may have any positive integral value including 0.

REAKCJA HARDY'EGO

„Nigdy przedtem nie widziałem czegoś takiego. Za ledwie jedną stronę wystarczyłoby, żeby zobaczyć, że może to być tylko praca matematyka najwyższego kalibru. Te wyniki muszą być prawdziwe, ponieważ gdyby nie były, nikomu nie starczyłoby wyobraźni, żeby je stworzyć.”

HARDY | LITTLEWOOD



I read in the proof sheets of Hardy on Ramanujan: "As someone said, each of the positive integers was one of his personal friends." My reaction was, "I wonder who said that; I wish I had." In the next proof-sheets I read (what now stands), "It was Littlewood who said..."

— *John Edensor Littlewood* —

“Nowadays, there are only three really great English mathematicians:
Hardy, Littlewood
and Hardy-Littlewood”

Reported by Harold Bohr, 1947



MODULAR EQUATIONS AND APPROXIMATIONS TO π

$$e^{\pi \sqrt{58}} = 24591257751.99999982\dots$$

Blisko liczby całkowitej, no i co dalej?

$$e^{i\pi\sqrt{18}} = 2\sqrt{7}, \quad e^{\pi\sqrt{22}/12} = 2 + \sqrt{2}, \quad e^{i\pi\sqrt{30}} = 20\sqrt{3} + 16\sqrt{6},$$

$$e^{i\pi\sqrt{34}} = 12(4 + \sqrt{17}), \quad e^{i\pi\sqrt{46}} = 144(147 + 104\sqrt{2}),$$

$$e^{i\pi\sqrt{42}} = 84 + 32\sqrt{6}, \quad e^{\pi\sqrt{58}/12} = \frac{5 + \sqrt{29}}{\sqrt{2}},$$

$$e^{i\pi\sqrt{70}} = 60\sqrt{35} + 96\sqrt{14}, \quad e^{i\pi\sqrt{78}} = 300\sqrt{3} + 208\sqrt{6},$$

$$e^{\pi\sqrt{55}/24} = \frac{1 + \sqrt{(3 + 2\sqrt{5})}}{\sqrt{2}}, \quad e^{i\pi\sqrt{102}} = 800\sqrt{3} + 196\sqrt{51},$$

$$e^{i\pi\sqrt{130}} = 12(323 + 40\sqrt{65}), \quad e^{\pi\sqrt{190}/12} = (2\sqrt{2} + \sqrt{10})(3 + \sqrt{10}),$$

$$\pi = \frac{12}{\sqrt{130}} \log \left\{ \frac{(2 + \sqrt{5})(3 + \sqrt{13})}{\sqrt{2}} \right\},$$

$$\pi = \frac{24}{\sqrt{142}} \log \left\{ \sqrt{\left(\frac{10 + 11\sqrt{2}}{4}\right)} + \sqrt{\left(\frac{10 + 7\sqrt{2}}{4}\right)} \right\},$$

$$\pi = \frac{12}{\sqrt{190}} \log \{(2\sqrt{2} + \sqrt{10})(3 + \sqrt{10})\}.$$

$$\pi = \frac{12}{\sqrt{310}} \log \left[\frac{1}{4}(3 + \sqrt{5})(2 + \sqrt{2}) \{(5 + 2\sqrt{10}) + \sqrt{(61 + 20\sqrt{10})}\} \right].$$

$$\pi = \frac{4}{\sqrt{522}} \log \left[\left(\frac{5 + \sqrt{29}}{\sqrt{2}} \right)^3 (5\sqrt{29} + 11\sqrt{6}) \right. \\ \left. \times \left\{ \sqrt{\left(\frac{9 + 3\sqrt{6}}{4}\right)} + \sqrt{\left(\frac{5 + 3\sqrt{6}}{4}\right)} \right\}^6 \right].$$

RAMANUJAN W CAMBRIDGE



I WOJNA ŚWIATOWA I LICZBY TAKSÓWKOWE

”Pamiętam, jak raz chciałem go (Ramanujana) odwiedzić, gdy leżał chory w Putney. Jechałem taksówką z numerem 1729. Powiedziałem mu, że ten numer jest raczej nieciekawym i mam nadzieję, że to nie był zły omen. – Nie – odparł – to jest bardzo interesujące; to najmniejsza (dodatnia) liczba wyrażalna jako suma dwóch sześciątów na dwa sposoby!”



Liczba taksówkowa

najmniejsza dodatnia liczba, która może być wyrażona jako suma dwóch sześcianów liczb naturalnych na n różnych sposobów.
Zwykle oznaczana jest $Ta(n)$ albo $Taxicab(n)$

$$Ta(1) = 2 = 1^3 + 1^3$$

$$Ta(2) = 1729 = 1^3 + 12^3 \\ = 9^3 + 10^3$$

$$Ta(3) = 87539319 = 167^3 + 436^3 \\ = 228^3 + 423^3 \\ = 255^3 + 414^3$$

$$Ta(4) = 6963472309248 = 2421^3 + 19083^3 \\ = 5436^3 + 18948^3 \\ = 10200^3 + 18072^3 \\ = 13322^3 + 16630^3$$

$$Ta(5) = 48988659276962496 = 38787^3 + 365757^3 \\ = 107839^3 + 362753^3 \\ = 205292^3 + 342952^3 \\ = 221424^3 + 336588^3 \\ = 231518^3 + 331954^3$$

$$Ta(6) = 24153319581254312065344 = 582162^3 + 28906206^3 \\ = 3064173^3 + 28894803^3 \\ = 8519281^3 + 28657487^3 \\ = 16218068^3 + 27093208^3 \\ = 17492496^3 + 26590452^3 \\ = 18289922^3 + 26224366^3$$

PO WOJNIE

1918 - Członek Royal Society (jako drugi Hindus w historii)

Marzec 1919 - powrót do Indii

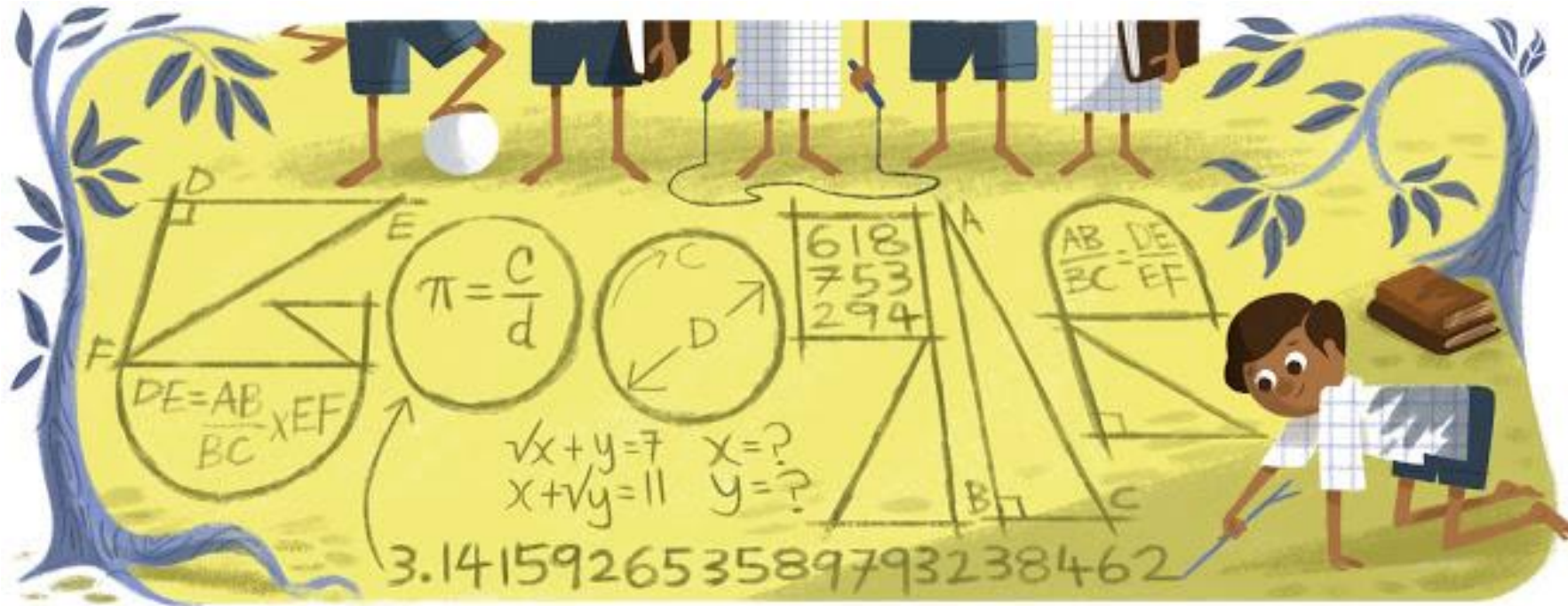
26 kwietnia 1920 – śmierć w wieku 32 lat



RAMANUJAN W POPKULTURZE



125 URODZINY RAMANUJANA



LISTA RZECZY IMIENIA SRINIVASA RAMANUJANA

The screenshot shows a Wikipedia article titled "List of things named after Srinivasa Ramanujan". At the top, there is a navigation bar with "Article" and "Talk" tabs, and a search bar. The article's main heading is "List of things named after Srinivasa Ramanujan". Below the heading, there is a notice: "This article needs additional citations for verification. Please help improve this article by adding citations to reliable sources. Unsourced material may be challenged and removed. (May 2018) Learn how and when to remove this template message." The article content is organized into several sections: "Contents (hide)", "Mathematics (hide)", "Journals (hide)", "Institutions and societies (hide)", "Prizes and awards (hide)", "Other (hide)", and "References (hide)". Each section contains a list of items named after Srinivasa Ramanujan. The "Mathematics" section includes items like "Srinivasa Ramanujan Diophantine equation", "Coxeter–Ramanujan identity", "Lambert–Ramanujan constant", "Ramanujan's congruence", "Hardy–Ramanujan number", "Ramanujan–Nagell equation", "Ramanujan–Peterson conjecture", "Ramanujan–Sudler–Bennett", "Ramanujan–Sundaram constant", "Ramanujan summation", "Ramanujan theta function", "Ramanujan graph", "Ramanujan's lacunarity", "Ramanujan's binary quadratic form", "Ramanujan prime", "Ramanujan's constant", "Ramanujan's and related", "Ramanujan's tau", "Rogers–Ramanujan identity", and "Ramanujan magic square". The "Journals" section includes "Ramanujan Journal", "Journal of the Ramanujan Mathematical Society", and "Ramanujan Journal". The "Institutions and societies" section includes "Ramanujan College, University of Delhi", "Ramanujan Institute for Advanced Study in Mathematics", "Srinivasa Ramanujan Institute of Technology", "Ramanujan Mathematical Society", "Srinivasa Ramanujan Centre at Sastra University (Srinivasa Ramanujan Institute)", "Srinivasa Ramanujan Concept School", and "Ramanujan IT City, Chennai". The "Prizes and awards" section includes "Srinivasa Ramanujan Medal" and "SASTRA Ramanujan Prize". The "Other" section includes "Ramanujan IT City, Chennai" and "Ramanujan Math Park, Chennai, Andhra Pradesh, India". The "References" section includes a citation: "Category: Lists of things named after mathematicians · Srinivasa Ramanujan". At the bottom of the page, there is a footer with the text: "This page was last edited on 24 December 2025, at 11:34 (UTC).", "Text is available under the Creative Commons Attribution-ShareAlike license; additional terms may apply. By using this site, you agree to the Terms of Use and Privacy Policy. Wikipedia is a registered trademark of the Wikimedia Foundation, Inc., a non-profit organization.", and "Privacy policy · About Wikipedia · Disclaimers · Contact Wikipedia · Developers · Content guidelines · Help center".

RÓWNANIA

Równanie Ramanujana–Nagella	$2^n - 7 = x^2$
Podział liczby całkowitej na składniki	$\sum_{n=0}^{\infty} p(5n+4)q^n = 5 \prod_{n=1}^{\infty} \frac{(1-q^{5n})^5}{(1-q^n)^6}$ $p(5k+4) \equiv 0 \pmod{5}$ $p(7k+5) \equiv 0 \pmod{7}$ $p(11k+6) \equiv 0 \pmod{11}$
Sumowanie Ramanujana	$1 + 2 + 3 + \dots = -\frac{1}{12} (\Re)$ $1 - 1 + 1 - \dots = \frac{1}{2} (\Re)$

Na pewnej ulicy domy są ponumerowane od 1 do n . Dom o numerze x ma taką własność, że suma numerów domów na prawo od niego jest równa sumie numerów na lewo. O n wiemy, że $50 < n < 500$. Ile wynosi n i x ?



ZAGADKA

PRZYBLIŻENIA PIERWIASTKA Z 2

$1, \frac{3}{2}, \frac{7}{5}, \frac{17}{12}, \frac{41}{29}, \frac{99}{70}, \frac{239}{169}, \frac{577}{408}, \frac{1393}{985}, \frac{3363}{2378}, \frac{8119}{5741}, \frac{19601}{13860}, \frac{47321}{33461}, \frac{114243}{80782}, \frac{275807}{195025}, \frac{665857}{470832},$

$\frac{1607521}{1136689}, \frac{3880899}{2744210}, \frac{9369319}{6625109}, \frac{22619537}{15994428}, \frac{54608393}{38613965}, \frac{131836323}{93222358}, \frac{318281039}{225058681}, \frac{768398401}{543339720},$

$\frac{1855077841}{1311738121}, \frac{4478554083}{3166815962}, \frac{10812186007}{7645370045}, \frac{26102926097}{18457556052}, \frac{63018038201}{44560482149}, \frac{152139002499}{107578520350}$

ROZWIĄZANIE ZAGADKI

{1, 1}

{8, 6}

{49, 35}

{288, 204}

{1681, 1189}

{9800, 6930}

{57121, 40391}

{332928, 235416}

{1940449, 1372105}

{11309768, 7997214}

{65918161, 46611179}

{384199200, 271669860}

{2239277041, 1583407981}

{13051463048, 9228778026}

{76069501249, 53789260175}



**ICTP Ramanujan Prize for
Young Mathematicians
from Developing Countries**

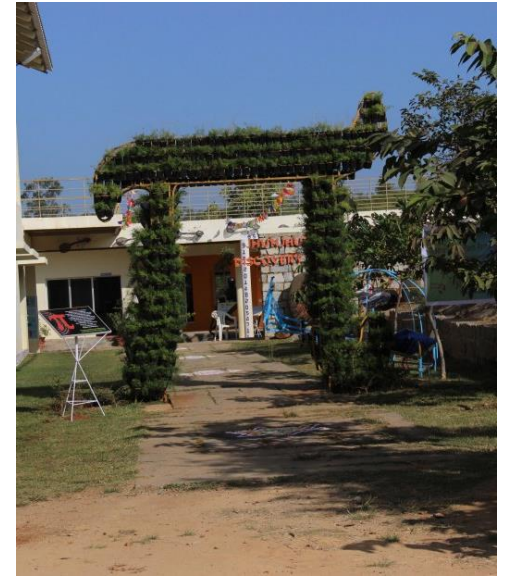
SASTRA Ramanujan Prize

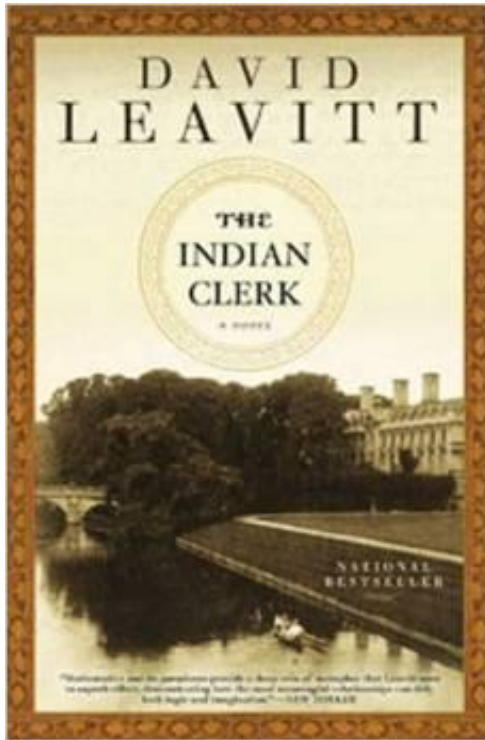
**Srinivasa Ramanujan
Medal**

NAGRODY

RAMANUJAN MATHS PARK

Chittoor, Andhra Pradesh

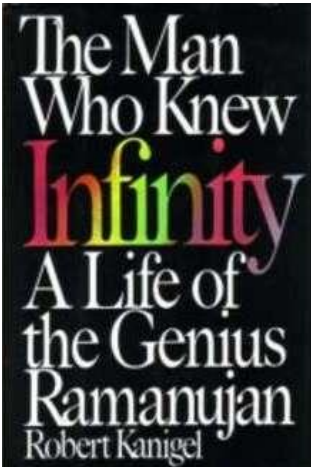




BIOGRAFIE

David Leavitt "The Indian Clerk" (2007)

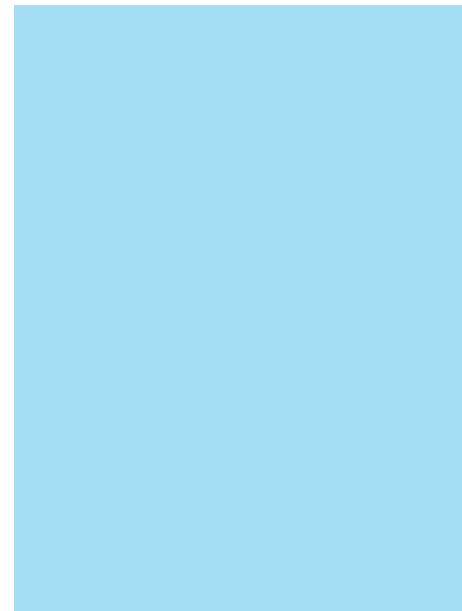
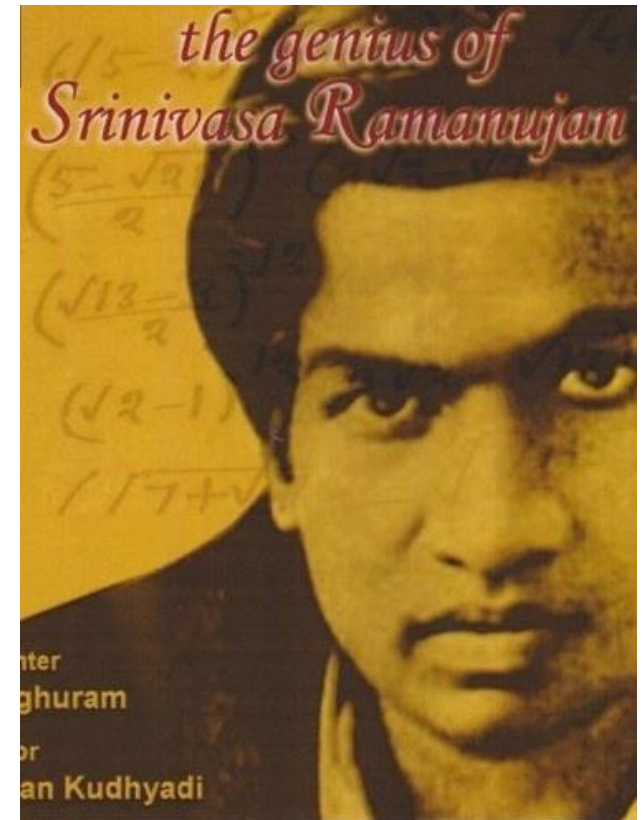
Robert Kanigel, "The Man Who Knew Infinity: A Life of the Genius Ramanujan" (1991)



RAMANUJAN W KINEMATOGRAFII

The Genius of Srinivasa Ramanujan (2013)

Ramanujan (2014)



CZŁOWIEK, KTÓRY POZNAŁ NIESKOŃCZONOŚĆ

Srinivasa Ramanujan – Dev Patel

G. H. Hardy – Jeremy Irons

Sir Francis Spring – Stephen Fry

John Edensor Littlewood – Toby Jones



BIBLIOGRAFIA

1. Seria „Świat jest matematyczny” – wydawnictwo RBA:
 - „Liczby pierwsze – W drodze do nieskończoności” Enrique Gracián
 - „Poezja liczb – Znaczenie piękna w matematyce” Antonio J. Durán
 - „Znamienite liczby – 0, 666 i inne osobistości świata liczb” Lamberto Garcia del Cid
2. https://plus.maths.org/content/ramanujan?fbclid=IwAR26g4G1dT84xCin4_qNMK_6v_CA666cA5CHsc6a1X3d6ZT2cS8MnSZDAg
3. <https://blog.stephenwolfram.com/2016/04/who-was-ramanujan/>
4. <http://madrasmusings.com/Vol%2020%20No%2021/from-port-trust-to-cambridge.html>
5. <https://pl.wikipedia.org/>
6. <https://www.filmweb.pl/film/Cz%20owiek%20kt%C3%B3ry+pozna%C5%82+niesko%C5%84czono%C5%9B%C4%87-2015-730736>