

CONJECTURE OF TWIN PRIMES (STILL
UNSOLVED PROBLEM IN NUMBER THEORY)
AN EXPOSITORY ESSAY

Hayat Rezgui

Abstract. The purpose of this paper is to gather as much results of advances, recent and previous works as possible concerning the oldest outstanding still unsolved problem in Number Theory (and the most elusive open problem in prime numbers) called "Twin primes conjecture" (8th problem of *David Hilbert*, stated in 1900) which has eluded many gifted mathematicians. This conjecture has been circulating for decades, even with the progress of contemporary technology that puts the whole world within our reach. So, simple to state, yet so hard to prove. Basic Concepts, many and varied topics regarding the Twin prime conjecture will be cover.

[Full text](#)

References

- [1] C. Aebi, G. Cairns, *Catalan Numbers, Primes, and Twin Primes*, Elem. Math., **63** (2008), 153–164. [MR2453139](#).
- [2] T. M. Apostol, *Introduction to Analytic Number Theory*, Springer-Verlag, New York, U.S.A., 1976. [MR0434929](#). [Zbl 0335.10001](#).
- [3] S. N. Baibekov, A. A. Durmagambetov, *Infinite Number of Twin Primes*, Advances in Pure Mathematics, **6** (2016), 954–971.
- [4] L. Bethune, *Found: New World Record Twin Primes!*, 2016: available at: <https://www.epcc.ed.ac.uk/blog/2016/09/27/found-new-world-record-twin-prime>.
- [5] R. P. Brent, *Tables Concerning Irregularities in the Distribution of Primes and Twin Primes up to 10^{11}* , Math. Comput., Vol. 30, N. 133, **198**, (1976).

2010 Mathematics Subject Classification: 11A41; 97Fxx; 11Yxx.

Keywords: Twin primes; Brun's constant; Zhang's discovery; Polymath project.

<http://www.utgjiu.ro/math/sma>

- [6] R. de la Bretèche, *Petits Écart s Entrenombrespriemiers Etpolymath: Une Nouvelle Manière de Faire de la Recherche en Mathématiques?*, SMF–Gazette, (2014), 19–31.
- [7] T. Buchert, *On the twin prime conjecture*, Adam Mickiewicz University in Poznań, Faculty of Mathematics and Computer Science, Master’s Thesis, 2011.
- [8] S. Budd, *The Distribution of Prime Numbers and its Applications*, Lakehead University, Thunder Bay, Ontario, CANADA, (2015), 1–30.
- [9] M. Chaves, *Twin Primes and a Primality Test by Indivisibility*, The Mathematical Gazette, Vol. 95, No. 533, (2011), 266–269.
- [10] P. Chengtong, Wang Yuan, *Chen Jingrun: A Brief Outline of His Life and Works*, Acta Math. Sin., New Ser., Vol. 12, No. 3, (1996), 225–233. [MR1457590](#). [Zbl 0862.01023](#).
- [11] W. W. L. Chen, *Distribution of Prime Numbers*, Imperial College, University of London, (2003), 1–81.
- [12] P. A. Clement, *Congruences for Sets of Primes*, Amer. Math. Mon., **56** (1949), 23–25. [MR0027771](#). [Zbl 0031.25205](#).
- [13] R. Crandall, C. Pomerance, *Prime Numbers: A Computational Perspective*, 2nd Edition., Springer, New York, U.S.A., 2005. [MR2156291](#). [Zbl 1088.11001](#).
- [14] M. T. Damir, *Bouded Gaps Between Primes*, Master Thesis, Universita Delgi Studi Di Padova, 2015.
- [15] J. P. Delahaye, *Premiers Jumeaux: Frères Ennemis*, Pour la Science, No. 260, (1999), 102–106.
- [16] J. Derbyshire, *Prime Obsession. Bernhard Riemann and the Greatest Unsolved Problem in Mathematics*, Joseph Henry Press, Washington, DC, U.S.A., 2003. [MR1968857](#). [Zbl 1034.11002](#).
- [17] W. Dunham, *A Note on the Origin of the Twin Prime Conjecture*, ICCM Not. 1, No. 1, (2013), 63–65. [MR3155198](#). [Zbl 1283.11004](#).
- [18] J. Ellenberg, *The Beauty of Bounded Gaps: A Huge Discovery About Prime Numbers and What it Means for the Future of Mathematics*, Math. Horizons, (2013), 5–7. [MR3313764](#).
- [19] J. Ellenberg, *How not to Be Wrong: The Power of Mathematical Thinking*, Penguin Group, New York, U.S.A., 2014. [Zbl 1358.00011](#).

Surveys in Mathematics and its Applications **12** (2017), 229 – 252

<http://www.utgjiu.ro/math/sma>

- [20] P. Erdős, *Some Remarks on Euler's- ϕ Function and Some Related Problems*, Bull. Amer. Math. Soc., **51**, No. 8, (1945), 540–544. [Zbl 0061.08005](#).
- [21] A. A. Ergin, *A Relation Between Prime Numbers and Twin Prime Numbers*. Math. Comput. Appl. 6, **2** (2001), 153–154. [MR1844564](#). [Zbl 1102.11300](#).
- [22] Euclid, *Elements. Alexandria, c. 300 BC*, for a modern edition, see Heath, T. L., "Thirteen Books of Euclid's Elements", Vol. I-III, 2nd edition revised with additions, Dover Publications, Inc. X, New York, U.S.A., 1956. [Zbl 0071.24203](#).
- [23] European Commision, *Open Science Monitoring. Impact Case Study–Polymath*, Research and Innovation, (2017), 1–10.
- [24] T. Forbes, *A Large Pair of Twin Primes*, Math. Comput., **66**, No. 217, (1997), 451–455. [MR1372004](#). [Zbl 0854.11005](#).
- [25] I. Gueye, *A Note on the Twin Primes*, South Asian J. Math., **2(2)** (2012), 159–161. [Zbl 1344.11010](#).
- [26] R. K. Guy, *Unsolved Problems in Number Theory*, Springer-Verlag, New York, U.S.A., 2004. [MR2076335](#).
- [27] H. Halberstam, H. E. Richert, *Sieve Methods*, Academic Press, New York, U.S.A., 1974. [MR0424730](#). [Zbl 0298.10026](#).
- [28] G. H. Hardy, E. M. Wright: Edited and revised by: D. R. Heath-Brown, J. H. Silverman, *An Introduction to the Theory of Numbers*, 6th Edition, Oxford University Press, 19979, 2008. [MR568909](#). [Zbl 1159.11001](#).
- [29] L. Harrison, *From Euclid to Present: A Collection of Proofs Regarding the Infinitude of Primes*, 2013.
- [30] R. Honsberger, *Mathematical Delights*, The Dolciani Mathematical Expositions, **28**, MAA, 2004. [MR2070472](#). [Zbl 1061.00003](#).
- [31] W. L. Hosch, *Twin Prime Conjecture. (Number Theory)*, 2016: available at: <https://www.britannica.com/topic/twin-prime-conjecture>
- [32] H. Iwaniec, *Sieve Methods*, Proceedings of the International Congress of Mathematicians, Helsinki, (1978), 357–364. [MR0562627](#).
- [33] F. Kennard, *Unsolved Problems in Mathematics*, Lulu.com, 2015.
- [34] E. G. Klarreich, *Together and Alone, Closing the Prime Gap*, Quanta Magazine, 2013: available at: <https://www.quantamagazine.org/20131119-together-and-alone-closing-the-prime-gap/>

- [35] T. Koshy, *Elementary Number Theory with Applications*, Elsevier Inc., 2007.
- [36] E. Kowalski, *Gaps Between Prime Numbers and Primes in Arithmetic Progressions (after Y. Zhang and J. Maynard)*, Séminaire BOURBAKI, 66ème Année, Société Mathématique de France (SMF), Vol. 2013/2014, Astérisque 367-368, 327-366, Exp. No. 1084, (2015). [MR3363595](#). [Zbl 1356.11066](#).
- [37] W. G. Leavitt, A. A. Mullin, *Primes Differing by a Fixed Integer*, Math. Comput., Vol. 37, No. 156, (1981), 581–585. [MR0628716](#). [Zbl 0511.10011](#).
- [38] H. Lee, Y. Park, *The Generalization of Clement's Theorem on Pairs of Primes*, J. Appl. Math. & Informatics Vol. 27, No. 1/2, (2009), 89–96.
- [39] P. A. Lindstrom, *Twin Primes and Goldbach's Conjecture*, Pi Mu Epsilon Journal, Vol. 13, No. 2, (2010), 105–106.
- [40] R. J. Lipton, K. W. Regan, *Twin Primes are Useful*, 2013: available at: <https://rjlipton.wordpress.com/2013/05/21/twin-primes-are-useful/>
- [41] J. Maynard, *Dense Clusters of Primes in Subsets*, Compositio Math., 152, No. 7, (2016), 1517–1554. [MR3530450](#). [Zbl 06619365](#).
- [42] O. Meldrum, *Promiscuous Primes. Is There a Pattern?*, Te Synapse (Oberlin College Science Magazine), Vol. 4, Issue 4, 2016, 26–27.
- [43] R. Melnik and I. Kotsireas, *Advances in Applied Mathematics, Modeling, and Computational Science*, Springer Science+Business Media, New York, U.S.A., (2013). [MR2963948](#).
- [44] J. Merlin, *Sur Quelques Théorèmes d'Arithmétique et un Énoncé qui les Contient*, Comptes Rendus Acad. Sci., Paris, FRANCE, **153** (1911), 516–518. [Zbl 42.0203.01](#).
- [45] H. Müller, *A Journey Through the World of Primes*, Mitt. Math. Ges. Hamb., **35** (2015), 5–18. [Zbl 1343.11007](#).
- [46] W. Narkiewicz, *Number Theory*, World Scientific Publishing Co Inc., 1984.
- [47] S. Nazardonyavi, *Some History about Twin Prime Conjecture*, arXiv:1205.0774 [math.HO], (2012), 1–26.
- [48] T. R. Nicely, *A New Error Analysis for Brun's Constant*, Virginia Journal of Science, Vol. 52, No. 1, (2001), 45–55. [MR1853722](#).
- [49] A. M. Odlyzko, *Sieve Methods*, A Senior Thesis, California Institute of Technology, Pasadena, California, U.S.A., 1971.

Surveys in Mathematics and its Applications **12** (2017), 229 – 252

<http://www.utgjiu.ro/math/sma>

- [50] R. J. L. Oliver, K. Soundararaja, *Unexpected Biases in the Distribution of Consecutive Primes*, Proc. Natl. Acad. Sci., U.S.A., **113**, No. 31, (2016), 1–17. [MR3624386](#).
- [51] M. Overholt, *A Course in Analytic Number Theory*, American Mathematical Society, 2014. [MR3290245](#). [Zbl 1335.11003](#).
- [52] A. P. Peretti, *Diophantine Equations and Riemann Hypothesis*, 2011.
- [53] A. de Polignac, *Recherches Nouvelles sur les Nombres Premiers*, C. R. Acad. Sci., Paris Math., **29** (1849), 738–739.
- [54] M. Ram P. Murty, *New Developments on the Twin Prime Problem and Generalizations*, Hardy-Ramanujan Journal, Hardy-Ramanujan Society, **37** (2015), 13–19. [MR3308471](#). [Zbl 06438661](#).
- [55] P. Ribenboim, *Prime Numbers Records*, Nieuw Arch. Wisk., IV. Ser. 12, No. 1–2, (1994), 53–65. [MR1284680](#). [Zbl 0829.11001](#).
- [56] P. Ribenboim, *Catalan's Conjecture. Are 8 and 9 the only consecutive powers?*, Academic Press, Inc., Boston, U.S.A., (1994), 0–12. [MR1259738](#). [Zbl 0824.11010](#).
- [57] P. Ribenboim, *The New Book of Prime Number Records*, Springer-Verlag, New York, U.S.A., 3rd ed., 1996. [MR1377060](#). [Zbl 0856.11001](#).
- [58] P. Ribenboim, *The Little Book of Bigger Primes*, Springer Science & Business Media, 2004. [MR2028675](#). [Zbl 1087.11001](#).
- [59] P. Ribenboim, *Prime Numbers, Friends Who Gives Problems. A Trialogue With Papa Paulo*, World Scientific Publishing, 2017. [Zbl 1358.00013](#).
- [60] H. Riesel, *Prime Numbers and Computer Methods for Factorization*, Birkhlluser Boston, 1994. [MR1292250](#). [Zbl 0821.11001](#).
- [61] P. M. Ross, *On Chen's Theorem that Each Large Even Number has the Form $p_1 + p_2$ or $p_1 + p_2 p_3$* , J. Lond. Math. Soc., **(2)10** (1975), 500–506. [MR0389816](#). [Zbl 0307.10049](#).
- [62] F. Saidak, *A Note on Euclid's Theorem Concerning the Infinitude of the Primes*, Acta Univ. M. Belii, Ser. Math., **24**, (2016), 59–60. [Zbl 06699480](#).
- [63] J. Sàndor, *Remark on Twin Primes*, Notes on Number Theory and Discrete Math., **20**, No. 3, (2014), 29–30. [Zbl 1344.11012](#).
- [64] M. d. Sautoy, *The Music of the Primes: Searching to Solve the Greatest Mystery in Mathematics*, Harper Press, 2003. [Zbl 1049.11002](#).

- [65] D. C. Shanks and J. W. Jr. Wrench, *Brun's Constant*, Math. Comput., **28**, No. 125, (1974), 293–299. [MR0352022](#).
- [66] T. Silde, *Elementary Sieve Methods and Brun's Theorem on Twin Primes*, MA3001 Analytic Number Theory, (2014), 1–12.
- [67] M. Sghiar, *La Relativité et la Théorie des Nombres*, hal-01174146v4, 2009.
- [68] W. Sierpiński, *A Selection of Problems in the Theory of Numbers*, (translated from the Polish by: A. Sharma), PWN jointly with Pergamon Press, The Macmillan Co., New York, U.S.A., 1964. [MR0170843](#).
- [69] R. Siegmund-Schultze, *Euclid's Proof of the Infinitude of Primes: Distorted, Clarified, Made Obsolete, and Confirmed in Modern Mathematics*, Math. Intell., **36**, No. 4, (2014), 87–97. [MR3282669](#). [Zbl 1350.11004](#).
- [70] R. Sreekantan, *Yitang Zhang and the Twin Primes Conjecture. Reducing the generation gap*, At Right Angles, Vol. 2, No. 3, (2013), 14–17.
- [71] M. Suzuki, *Alternative Formulations of the Twin Prime Problem*, Amer. Math. Monthly., Vol. 107, No. 1, (2000), 55–56. [MR1745569](#). [Zbl 0986.11003](#).
- [72] J. J. Tattersall, *Elementary Number Theory in Nine Chapters*, Cambridge University Press, 1999. [MR1720399](#). [Zbl 0958.11001](#).
- [73] T. Tao, *What's New: Updates on My Research and Expository Papers, Discussion of Open Problems and Other Maths-Related Topics*, 2016: available at: <https://terrytao.wordpress.com/tag/twin-primes/>.
- [74] A. Titu and D. Andrica, *Number Theory: Structures, Examples and Problems*, Birkhäuser Boston, Inc., Boston, U.S.A., 2009. [MR2492316](#).
- [75] H. Tronmolone, *A Tale of Two Primes*, COLAUMS Space, Issue 3, (2013), 18–23.
- [76] R. Vanlalngaia, *Fonctions de Hardy des Séries L et Sommes de Mertens Explicites*, Thèse de Doctorat, Université Lille 1, FRANCE, 2015.
- [77] D. G. Wells, *Prime Numbers: The Most Mysterious Figures in Math*, John Wiley & Sons, Inc., Hoboken, New Jersey, U.S.A., 2005.
- [78] S. Y. Yan, *Number Theory for Computing*, Springer-Verlag, Berlin Heidelberg, 2000. [MR1756471](#).
- [79] Y. Zhang, *Bounded Gaps Between Primes*, Ann. Math. (2)179, No. 3, (2014), 1121–1174. [MR3171761](#). [Zbl 1290.11128](#).

Surveys in Mathematics and its Applications **12** (2017), 229 – 252

<http://www.utgjiu.ro/math/sma>

Hayat Rezgui
Laboratory: E.D.P.N.L. and Department of Mathematics,
École Normale Supérieure,
B.P. 92, Vieux Kouba, 16308, Algiers, Algeria.
E-mail: rezguihayat@gmail.com

License

This work is licensed under a [Creative Commons Attribution 4.0 International License](https://creativecommons.org/licenses/by/4.0/). 

Surveys in Mathematics and its Applications **12** (2017), 229 – 252
<http://www.utgjiu.ro/math/sma>