

The Circle of Legend: Rise and Return of Évariste Galois

Children play the game of telephone to have a laugh when “hot dog” turns into “hairy log,” but historians work to accurately record the past. Thanks to such diligence, biographies avoid gradually deviating from reality as time passes. At least, they should. Yet this was not so for retellings of the life of French mathematician Évariste Galois. The true story is spectacular enough -- with youthful rebellion, ardent politics, and a fateful duel -- but generations of romantic scientists wove myth alongside truth. These writers told a glorious and half-fabricated tale of how a society of fools persecuted an innocent, misunderstood genius. The legend grew until an article published hardly forty years ago reined in the narrative again, basing it not on imagination but on primary sources. Galois’ biographers at last began to acknowledge that he was imperfect, and that his misfortunes were in large part self-fulfilled. In this paper, we examine how men across centuries played the game of telephone to transform Galois from a martyred radical into a French hero, then a scientific icon and finally back to a humanized genius.

ERA 0: The Life of Évariste Galois (1811 - 1832)

Before we can dissect subsequent exaggerations and fabrications, we must first see the true events of Galois’ life. To do this, we first lay out an abridged history of early 1800s France, because politics were central to Galois.

The seed event was, of course, the French Revolution of the 1790s. It started in the winter of 1788/1789 when the French working class lived through a bad harvest followed by fifty consecutive days of below-freezing temperatures. This rekindled interest in enlightenment ideals like democracy because the working class saw a stark contrast between their hardship and the lavish lives of the nobility. At the same time, Louis XVI needed to raise taxes because France was in debt after helping the US gain independence from Britain. But his plan backfired when delegates of the Third Estate swore the Tennis Court Oath of 1789, vowing to transform France into a constitutional monarchy. As the revolution intensified, Louis XVI eventually fled from France, and a new republic was born. Then came the Reign of Terror, in which the government zealously guillotined suspected political enemies. The revolution reached its height under Napoleon Bonaparte, who was named Consul for life in 1802. While Napoleon led France to military victories, he also slowly began to restore France’s pre-Revolution nobility and certain restrictions on the press. A decade later, in 1814, British and Prussian forces defeated Napoleon once and for all at Waterloo, ushering in the Bourbon restoration of old European powers. Thus, the revolution came full circle, with France yet again ruled by a monarch, Louis XVIII. But the old powers of Europe could not squash revolutionary ideals. When Louis XVIII died in 1824, many thought that his replacement, Charles X of France, was “old and reactionary.”¹

Additionally, industrialization had turned “much of Paris into a horrible slum, in which hundreds of thousands dwelt in misery and near-starvation.” For Parisians, the last straw was a recession in 1830. A mob ruled the city by July and forced Charles X to flee. The newly instated

¹ John Derbyshire, *Unknown Quantity: A Real and Imaginary History of Algebra* (United States: National Academies Press, 2006), p. 207.

King Louis Philippe satisfied many as a liberal himself, but radicals “could not be satisfied by any mere liberal.”²

The late 1820s and early 1830s were the formative years of Galois’ political life. He spent his teenage years participating in radical republican secret societies and serving jail time, and his political activity will play a central role in his story.

With that said, we now turn to a short summary of Galois’ life. Without this summary as a foundation, discussing how biographers later changed or fabricated details would be difficult. This version of Galois’ life attempts to reflect the most modern perspectives by in essence summarizing from Tony Rothman,³ whose work we examine in more detail in Era 3. The eras are my personal attempt to divide the historiography of Galois into pieces. As with all periodization, they reflect a measure of bias, but the reasoning behind the cutoffs should become clear as the paper progresses. With that, let us start at the beginning.

Évariste Galois was born on October 25, 1811, in the French town of Bourg-la-Reine, near Paris. His mother, Adelaide-Marie Demante, homeschooled him until the age of twelve. His father, Nicholas-Gabriel Galois, was elected mayor of Bourg-la-Reine in 1815. In October, 1823, Galois began to attend a preparatory school in Paris called the Lycée Louis-le-Grand. During the first semester, a number of students protested against the provisor of planning for trying to return Jesuits to the school, and forty students were expelled as a result. While Galois was not one of the forty, the experience may have stuck with him.⁴

Galois earned good marks and didn’t enroll in a math course until after his first year. His first math class was in geometry, and in the class Galois received progress reports with comments such as “zeal and success,” “zeal and progress very marked.” He also began to read contemporary papers by Lagrange, showing a mathematical talent and drive. His math teacher implored him to work systematically, not so much in his head. As his passion for mathematics grew, so did his work slack in other subjects. After a trimester of the geometry class, Galois’ progress report changed from an overall score of “marked” to “not very satisfactory,” and his character shifted from “good, but singular” to “closed and original.”⁵ The trend toward reservedness continues as Galois’ life goes on.

Despite advice to wait, in 1828 Galois attempted the admissions exam to the prestigious l’École Polytechnique a year early and failed. He had not taken the special preparatory course, and he may not have properly explained what he did know due to his habit of doing math in his head. According to Rothman, “this and subsequent rejections embittered him for life.”⁶ Throughout his teenage years, Galois perceived ever more injustice in his life, and from that perception often acted rashly to his own detriment.

He did not stop doing mathematics, however. When Galois enrolled in the mathematics class of Louis Richard later in 1828, he blossomed because Richard recognized great ability

² Derbyshire, p. 208.

³ Tony Rothman, “Genius and Biographers: The Fictionalization of Evariste Galois,” *American Mathematical Monthly*, Vol. 89, No. 2 (February 1982), p. 84-106.

⁴ Rothman, p. 86.

⁵ Rothman, p. 86-87.

⁶ Rothman, p. 87.

within Galois and encouraged him. It is during this time that he most likely began fundamental work on the theory of equations. Today his work in this field bears the name Galois Theory.

In May and June of 1829, Galois submitted his research to the Academy of Sciences. The mathematician Cauchy refereed the paper and, contrary to many accounts, did not lose or throw away the memoir. On the contrary, a letter he wrote shows he knew of Galois and was impressed with his work, perhaps even encouraging Galois to revise the paper and submit it for the Grand Prize in mathematics, for which the deadline was March 1830.⁷

In the meantime, a tragedy befell Galois. A reactionary (anti-republican) priest forged the signatures of Galois' father on a number of scandalous papers directed toward relatives. Galois' father committed suicide soon after. The loss Galois felt for his father will resurface later when he serves jail time, but the suicide also had a much more pressing consequence for Galois. His second admissions exam for entrance to the Polytechnique occurred mere days afterward. As might be expected, he failed. The legend goes that Galois became so enraged at the stupidity of his examiner that he threw an eraser at him. This story is unsubstantiated; the most likely reason for Galois' failure is some combination of untrained communication skills and fresh grief. Regardless of the cause of his failure, Galois would not apply for entrance to the Polytechnique again.

Returning to the topic of the Grand Prize for mathematics, Galois ended up submitting the paper in February 1830. The Academy appointed the mathematician Fourier to read the paper, but due to a tragic coincidence, Fourier died in his home before he could read the paper. The other referees did not realize Fourier had the paper, so they awarded the Grand Prize to Jacobi and posthumously to Abel. Galois did not consider this a coincidence (although modern evidence around Fourier's death suggests there were no secret, colluding forces out to get Galois). As will become a theme in the remainder of his life, this misfortune nudged him toward paranoia. More and more, this paranoia would lead Galois to begin to "[participate] in the creation of his own disasters."⁸

The primary outlet for Galois' paranoia became his political activities. The École Polytechnique was a breeding ground for radical students; a large part of why Galois wanted to attend was so he could participate. In the July revolution of 1830, Galois yearned to march in the streets with the other Republicans as they ousted Charles X and replaced him with Louis-Philippe. The director of l'École normale, however, locked the students inside the school so they could not join the bloody revolution in the streets. Galois tried scaling the walls to no avail and came to resent the director for barring him from joining the fray. He wrote a scathing letter condemning the director in *Gazette des Ecoles*, which promptly got him expelled.

Galois' unstable tendencies continued into the beginning of 1831. In January, no longer a student, he attempted to organize a private mathematics class. Forty students came to the first session (mostly republican friends), but due either to Galois' increasing political activities or the extremely advanced mathematics he decided to cover, the class ended soon after it began⁹. Having returned home, Galois apparently also insulted his mother to the extent that he drove her out. In a letter written on April 18 to her colleague Libri, mathematician Sophie Germain states that

⁷ Rothman, p. 88.

⁸ Rothman, p. 89.

⁹ Rothman, p. 90.

Galois “continued his habit of insult [...]. The poor woman fled her house [...] and has been forced to place herself as a companion in order to make ends meet.”¹⁰ In other words, Galois could not even control himself before his mother, who homeschooled him for all his early life.

In the same month as Galois returned home, he also continued his fervent politics. Galois likely joined a radical republican secret society called the Society of the Friends of the People before December 1830. He also joined the “Artillery of the National Guard, a branch of the militia which was almost entirely composed of republicans,” at least before mid-December.¹¹ In short, radical politics grew more and more central to Galois’ life.

In December of 1830, a group of nineteen officers from the Artillery of the National Guard were arrested for a suspected conspiracy to overthrow the government. By April, they were acquitted and a number of republicans planned a banquet on May 9, 1831, to celebrate. Galois attended. Here sat about two hundred of the most radical republicans in the city, the republicans who were not satisfied with King Louis-Philippe, no matter him being more liberal than his predecessors. At the banquet, Galois proposed a toast in which he stood with an open knife in his hand and said, “To Louis-Philippe.” The other republicans interpreted this as a clear threat on the king’s life, so they cheered boisterously. The following day, Galois was arrested at his mother’s home; there were likely informers attending the banquet.¹²

At court on June 15, Galois’ defense lawyer claimed Galois said, “To Louis-Philippe, *if he betrays,*” and that the second clause was drowned out in the uproar that followed the toast. Galois proceeded to provide acceptable answers to the rest of the prosecutors’ questions. Perhaps on account of his youth, the jury acquitted him almost immediately.¹³

Galois walked barely three weeks as a free man, however, before he was found with a friend named Duchatelet dressed in a uniform of the Artillery Guard on Bastille Day, July 14. The uniform was illegal because the Artillery Guard had been dissolved in late December; furthermore, Galois had a loaded rifle and a dagger. Galois’ trial was set for October, and he was put in prison until then. Very likely, the loss of his father and the bitterness he felt toward the Academy’s rejections played a role in his increasingly erratic, paranoid behavior. Galois’ problems resulted from “his own inability to keep out of trouble,”¹⁴ not an oppressive society as the legend goes.

While in prison two incidents stand out. Both were recorded by a prison-mate of Galois’ named Francois Raspail, who was an “early botanist” and who later became a “famous statesman.”¹⁵ The first was when Galois, both unstable and encouraged by his fellow prisoners, drank himself into a stupor. Galois, as Rothman writes, “pours out his soul to Raspail in haunting prophecy.” Here is part of what Galois said, excerpted from a letter Raspail wrote on July 25:¹⁶

And I tell you, I will die in a duel on the occasion of some *coquette de bas étage*. Why? Because she will invite me to avenge her honor which another has compromised.

¹⁰ Rothman, p. 91.

¹¹ Rothman, p. 90.

¹² Rothman, p. 93.

¹³ Rothman, p. 93.

¹⁴ Rothman, p. 94.

¹⁵ Rothman, p. 95.

¹⁶ Rothman, p. 94.

Do you know what I lack, my friend? I can confide it only to you: it is someone whom I can love and love only in spirit. I've lost my father and no one has ever replaced him, do you hear me...?

Soon afterward, Galois in delirium attempted suicide. He would have succeeded if his prison-mates hadn't forcibly stopped him. Together, a picture emerges of a broken Galois: a teenager of fiery idealism and lacking self-control who nonetheless sustained an inner wound formed by a lost father and a string of rejections.

The second incident occurred on August 2, when a prisoner was shot in a room "open in all directions through six windows." Galois was present in the same room as the shot prisoner and was later thrown in the dungeon, perhaps for insulting the superintendent. Rothman argues that the evidence is strongly against this event being a failed attempt on Galois' life.¹⁷

Sometime in October,¹⁸ Galois received news that a memoir he had submitted to the Academy back in January on the resolution of equations had been rejected by a mathematician named Cauchy. Enraged at the further rejection, he "gave up plans to publish papers through the Academy and decided to publish them privately."¹⁹ Because it shows a vivid snapshot of Galois' frustration at the time, we quote here the first page of the preface to his self-published papers:²⁰

Firstly, you will notice the second page of this work is not encumbered by surnames, Christian names or titles. Absent are eulogies to some prince whose purse would have opened at the smoke of incense, threatening to close once the incense holder was empty. Neither will you see, in characters three times as high as those in the text, homage respectfully paid to some high-ranking official in science, or to some savant-protector, a thing thought to be indispensable (I should say inevitable) for someone wishing to write at twenty. I tell no one that I owe anything of value in my work to his advice or encouragement. I do not say so because it would be a lie. If I addressed anything to the important men of science or of the world (and I grant the distinction between the two at times is imperceptible) I swear it would not be thanks. I owe to important men the fact that the first of these papers is appearing so late. I owe to other important men that the whole thing was written in prison, a place, you will agree, hardly suited for meditation, and where I have been dumbfounded at my own listlessness in keeping my mouth shut at my stupid, spiteful critics: and I think that I can say "spiteful critics" in all modesty because my adversaries are so low in my esteem. The whys and wherefores of my stay in prison have nothing to do with the subject at hand; but I must tell you how manuscripts go astray in the portfolios of the members of the Institute, although I cannot in truth conceive of such carelessness on the part of those who already have the death of Abel on their consciences. I do not want to compare myself with that illustrious mathematician but, suffice to say, I sent my memoir on the theory of equations to the Academy in February of 1830 (in a less complete form in 1829), and it has been impossible to find them or get them back. There are other anecdotes in this genre but I would be ungracious to recount them because, other than the loss of my manuscripts, those incidents do not concern me. Happy voyager, only my poor countenance saved me from the jaws of wolves. Perhaps I have already said too much for the reader to understand why, as much I would have liked otherwise, it is absolutely impossible for me to embellish or disfigure this work with a dedication.

¹⁷ Rothman, p. 95-96.

¹⁸ Rothman explains on p. 93 that he has found "no other source which either corroborates or contradicts" that Galois received news of his memoir's rejection only in October, aside from Leopold Infeld.

¹⁹ Rothman, p. 96.

²⁰ Rothman, p. 97.

On March 16, 1832, Galois was transferred to the pension Sieur Faultrier as part of an effort by the prison to protect inmates from a cholera epidemic sweeping Paris at the time. It is likely that during this time Galois became interested in the daughter of a physician at Faultrier named Stéphanie du Motel. The identity of Stéphanie was discovered in 1968 when the scholar C. A. Infanzoschi used a magnifying glass to scrutinize an original letter that Galois wrote while at Faultrier -- the name at the bottom was fiercely blotted out by Galois, but Infanzoschi managed to discern it anyway.²¹ Galois wrote a number of letters back and forth with Stéphanie that tell the story of a "broken love affair,"²² halted by Stéphanie. Galois did not take this lightly.

It must be stated that at this point in the story there are very few solid facts, and much more speculation. What is known for certain is that Galois sent a series of three letters the night before he died in a duel against an unknown combatant.

One was directed to his friend Auguste Chevalier and contained a summary of what Galois already wrote in the memoir rejected by Poisson. It implored Chevalier to show Galois' work to leading mathematicians such as Jacobi in the hope that some "find it profitable to sort out this mess."²³ This letter is important because later biographers blew it out of proportion by implying that somehow Galois invented his entire theory on this last night.²⁴ Clearly this was not the case, because Galois submitted similar work in his memoir on the resolution of equations back in January 1831. The other two letters were directed to several republican friends. One contained the line, "forgive those who kill me for they are of good faith." The other contained the line, "Your task is simple: prove that I am fighting against my will, having exhausted all possible means of reconciliation; say whether I am capable of lying even in the most trivial matters."²⁵

The second of these last two letters is the basis of a horde of theories about the reasons behind the duel that would occur the following morning. Some claimed that Galois had "run afoul" of political enemies,²⁶ others that republicans suspected Galois had turned on them and murdered him as a result,²⁷ and still others that Stéphanie was a secret provocateur placed to incense Galois into a duel with a police agent of Louis-Philippe's.²⁸ These theories will get due explanation in Era 2. For now, know that each is unlikely according to Rothman.

Despite the mystery surrounding the circumstances of the duel, the date of the duel and the events immediately after it are known. On May 30, Galois and an opponent met near the pension Sieur Faultrier with pistols in hand. The duel commenced, and Galois received a deadly bullet in the abdomen. Abandoned, Galois was found later that day by a passing peasant who brought him to the nearby Hospital Cochin. The next morning, at ten o'clock, he died. His last words were to his younger brother:

"Don't cry, Alfred. I need all my courage to die at twenty."

²¹ Rothman, p. 101.

²² Rothman, p. 97.

²³ Rothman, p. 102-103.

²⁴ Eric Temple Bell, *Men of Mathematics* (New York: Simon and Schuster, 1937), p. 375.

²⁵ Rothman, p. 97-98.

²⁶ Bell, p. 375.

²⁷ Fred Hoyle, *Ten Faces of the Universe* (San Francisco: W. H. Freeman, 1977), Chap. 1.

²⁸ Leopold Infeld, *Whom the Gods Love: The Story of Evariste Galois* (New York: Whittlesey House, 1948).

ERA 1: The Original Biographers (1832 - 1921)

Despite Galois' habit of viewing himself as an outsider, evidence of his popularity came when two or three thousand republicans attended his funeral.²⁹ Multiple stories about him got published in Paris newspapers. One of them was an obituary³⁰ by Galois' friend Chevalier that contained the first biography of Galois. According to historian of mathematics Amir Alexander, Chevalier's piece was "heartrending" as it detailed the "long and sad tale of the young genius' encounters with the scientific establishment". Chevalier also implied that Galois' turn to radical republicanism was a result of the pain of his continued rejections from the academy. It was the stays in prison, according to Chevalier, that were the final straw for Galois: the second time through prison, "death awaited him upon his release." Chevalier concluded his obituary with the line, "The child of the poor, martyred by his genius, the heart compressed, hands tied together, the mind on fire, advances through life in fall after fall, or even torment after torment, to the morgue or to the scaffold." This may have been "something of an anthem to the republican revolutionaries in the 1830s," but regardless, it sealed the essential framework of what would become the Galois legend.³¹ Not only does Chevalier imply that the reason for the premature death of his friend was the mathematicians of the academy, but his final line sets Galois as a literal martyr of his own genius, with no outlet existing for such a fiery mind.

Thus, the memory of the irreverent, flawed Galois dissipated soon after his death. This was largely due to passionate writing like Chevalier's that diverted blame from Galois, and likely also due to the drama surrounding the whole affair. In addition, one might imagine that the oppressed genius story served the radical republican cause better than a more human one.

Meanwhile, Chevalier and Galois' brother, Alfred, made many copies of Galois' original manuscripts. They sent these copies to prominent mathematicians to no avail. Galois was nearly forgotten for a decade, his memory carried forward only by close friends and his prison-mate Raspail.³²

In 1843, however, the rising French mathematician Liouville received or discovered³³ a copy of Galois' papers. At last, Galois received a thorough reading. Liouville saw the power of Galois' methods and published his work in 1846 in the *Journal de Mathématiques Pures et Appliquées*.³⁴ In fact, Liouville wrote of Galois' work in the highest terms. At the same time, Liouville acknowledged the difficulty his colleagues faced a decade ago in recognizing Galois' work by commenting on Galois' obscure style and extreme brevity. As Amir Alexander cautions, this may simply be because Cauchy (a chief antagonist from Galois' perspective) was still alive

²⁹ Amir R. Alexander, *Duel at Dawn: Heroes, Martyrs, and the Rise of Modern Mathematics* (United Kingdom: Harvard University Press, 2010), p. 92-93.

³⁰ Auguste Chevalier, "Évariste Galois," *Revue Encyclopédique*, September 1832, p. 744.

³¹ Alexander, p. 93.

³² Alexander, p. 94.

³³ It is not clear how Liouville came upon Galois' manuscripts. The most likely way may be through Alfred or Chevalier, but this would imply they were still searching for mathematicians who could review Galois work over a decade after his death.

³⁴ Joseph Liouville, ed., "Oeuvres mathématiques d'Évariste Galois," *Journal de Mathématiques Pures et Appliquées* 9 (October-November, 1846), p. 381-444.

and in fact Louville's superior in the academy. Thus, Louville had no incentive to join with Galois' acolytes in slandering Cauchy.³⁵

Regardless, with the approval of the French mathematical establishment, Galois could no longer be "dismissed as a hotheaded amateur treading the margins of sanity."³⁶ An article published in the popular Parisian magazine *Magasin Pittoresque* in 1848, likely authored by a former friend of Galois', shows the last remnants of a radical tinge,³⁷ but even it focuses more on Louville's role in reviving Galois' contributions than on Galois' own turbulent life. A transformation then occurred, which Alexander captures well:³⁸

Subsequent accounts of Galois are of a different character altogether, for they carry the official imprint of the French scientific establishment. [...] Ironically, the legend of Galois, the young genius driven to an early death by a jaded scientific establishment, became a founding myth of the very institutions that had spurned him during his lifetime. Even the *École normale*, which had expelled Galois in disgrace in 1831, now embraced him as its brightest star.

In other words, as Galois' work assimilated into the body of known mathematics over the coming decades, his story grew past the radical fringe to become a "staple of the scientific establishment itself."³⁹ The halo of fervent republicanism and anti-institutional sentiment that surrounded Galois' life flipped to become a myth on which, ironically, scientific institutions based part of their history.

Despite his new status as a model French scientist, Galois was not examined by any true historian for many decades. That changed in 1895 when the *École normale* celebrated its 100th anniversary in part by commissioning Norwegian mathematician Sophus Lie to write an essay on Galois, who the school decided was its most notorious student. After Lie focused only on the mathematical merits of what was then called Galois theory, the editors wanted to include a brief biographical segment, too, as this was an equal part in Galois' fame. The editors decided to commission historian Paul Dupuy (1856 - 1948), who "took the assignment seriously."⁴⁰

Dupuy interviewed Galois' living relatives and acquaintances and scoured records from l'École normale, the academy, the jail Galois stayed at, the pension *Sieur Faultrier*, and the *Hospital Cochin* to find every scrap of paper written by Galois that he could. The project soon ballooned out of proportion for a mere biographical postscript to Lie's essay, so Dupuy decided to publish it as a full biography, which he released in 1896.

His book, *La vie d'Évariste Galois*, was, according to Alexander, "on the whole, balanced and sober." Alexander also notes that, as a "Dreyfusard,"⁴¹ Dupuy likely felt sympathy toward

³⁵ Alexander, p. 95.

³⁶ Alexander, p. 94.

³⁷ "Évariste Galois," *Magasin Pittoresque* 16 (1848), p. 227-228.

³⁸ Alexander, p. 96.

³⁹ Alexander, p. 95.

⁴⁰ Alexander, p. 96.

⁴¹ The Dreyfus Affair of 1890s France was a political scandal involving a Jewish soldier named Alfred Dreyfus who was convicted for treason against the French military. Through rigged trials and anti-semitism, the government continued to prolong his jail sentence even as evidence came to light that he was innocent. Eventually Dreyfus was acquitted and allowed to serve in WWI. The issue split France into a Republican, anti-clerical camp and a conservative, Catholic camp. It is often referred to as "the Affair" because of its importance.

Galois' radical republican cause more than 60 years ago. One of Dupuy's central claims is that Galois' true home was in the pure, mathematical world rather than crass society. He also responds to the common lament of "Imagine how far mathematics would have advanced if Galois had lived beyond twenty" with "Galois fulfilled his destiny."⁴² In other words, he says Galois' political inclinations would have led to his death regardless of the duel, perhaps in the June Rebellion of 1832.

Other French institutions embraced Galois at a similar time to Dupuy. The president of the Mathematical Society of France echoed Chevalier's "martyred by his own genius" when he wrote, "Alas! It seems that the unfortunate young man sadly paid the ransom of his genius."⁴³ Historian and teacher at l'École normale Jules Tannery collected further documents related to Galois which he published in 1908. Tannery also gave a speech⁴⁴ in which he claimed, like Dupuy, that Galois belonged to the abstract world of mathematics; in claiming this, he reinforced that the institutions of the real world had treated him poorly. Indeed, later in the speech, Tannery apologized officially on behalf of l'École normale for how the school treated Galois almost eighty years ago. Nowhere in the speech did Tannery mention Galois' paranoia or his talent for making enemies.

In Alexander's words, it was with this "official makeover" that Galois was "installed in the pantheon of official French heroes."⁴⁵ Already, retellings of the life of Galois had shifted from his radical republican roots (punctuated by a forgotten decade) to his scientific acclaim and finally his station as a French hero. All that remained was to expand past France to create a truly universal legend.

ERA 2: The Legend Makers (1921 - 1982)

The year 1921 marks the first English translation of Galois' biography by George Sarton,⁴⁶ who based his biography on Dupey. Galois' story, which was up to this point available only to French speakers, now became available to a much larger, English-speaking audience. Sarton did not only translate, however; he also added his own spin to the narrative.

Illustrating his new perspective, Sarton's first paragraph departs immediately from the more rigorous, historical approach undertaken by Dupey, and even surpasses the praises of Tannery:⁴⁷

No episode in the history of thought is more moving than the life of Evariste Galois -- the young Frenchman who passed like a meteor about 1828, devoted a few feverish years to the most intense meditation, and died in 1832 from a wound received in a duel, at the age of twenty. He was still a mere boy, yet within these short years he had accomplished enough to prove indubitably that he was one of the

⁴² Alexander, p. 97.

⁴³ Évariste Galois, *Oeuvres Mathématiques d'Évariste Galois*, publiées sur les auspices de la Société Mathématique de France avec une introduction par Émile Picard, membre de l'Institut (Paris: Gauthiers-Villars et Fils, 1897).

⁴⁴ Jules Tannery, "Discours prononcé à Bourg-la-Reine," *Bulletin des Sciences Mathématiques*, 2nd ser., 33 (1909), p. 158-164.

⁴⁵ Alexander, p. 99.

⁴⁶ George Sarton, "Évariste Galois," *Osiris*, vol. 3 (1937), p. 241-259. This article was first published in *Scientific Monthly*, October 1921, p. 363-375.

⁴⁷ Sarton, p. 241.

greatest mathematicians of all time. When one sees how terribly fast this ardent soul, this wretched and tormented heart were consumed, one can but think of the beautiful meteoric showers of a summer night. But this comparison is misleading, for the soul of Galois will burn on throughout the ages and be a perpetual flame of inspiration. His fame is incorruptible; indeed the apotheosis will become more and more splendid with the gradual increase of human knowledge.

Sarton goes on to laud the fundamental value of Galois' work, comparing his ideas to an orange tree that will grow more fruit as time moves forward, as opposed to a single orange, which is better if one is starving but worse in the long run. Following through with his own prophecy of Galois' apotheosis, Sarton says that Galois' personality "will appear to [mathematicians of the future] to be surrounded by the same halo of wonder as those of Euclid, Archimedes, Descartes, and Newton."⁴⁸ Sarton's goal seems less to provide a historical narrative of Galois and more to build a "universal archetype, the very model of a young scientific genius".⁴⁹

Indeed, in Sarton's biography of Galois' life, he highlights tragedies that place Galois as a victim. One example of this is when he claims that Galois' first submission "got lost through Cauchy's negligence,"⁵⁰ which modern evidence disproves.⁵¹ Perhaps the most significant example, however, is when Sarton suggests that Galois "plunged himself entirely" into politics because "Galois' academic career was entirely compromised, the bridges were burned."⁵² Sarton places this statement directly after a line explaining how Poisson rejected Galois' second memoir, saying that "this was the last straw." The narrative fits until one remembers to check chronology! Poisson's rejection was written on July 4, 1831, and some claim that Galois did not receive word of the rejection until October. Regardless, Galois was deeply entrenched in politics -- arrested either once or twice, and a former member of the Artillery of the National Guard -- before he knew any decision had been made. Hence Galois' politics must not have stemmed from this second rejection; instead they were his own choice. In writing Galois as a victim of the establishment, Sarton takes the first steps toward creating a legend reminiscent of Galileo, in which fools persecute a lone genius.

In spite of all Sarton's aggrandizement, he at least acknowledges pieces of Galois' role in manufacturing his own troubles. For example, Sarton writes that it was in part the unjust death of Galois' father that "developed his tendency to see injustice and baseness everywhere."⁵³ Sarton also concedes that "Galois' temper was not altogether amiable."⁵⁴ But Sarton is unable to maintain this grounding in reality for long. In the very next paragraph, he reverts to Chevalier's perspective when he describes Galois as "a victim of a bad social organization which ever sacrifices genius to mediocrity". Thus, Sarton's handful of overtures to Galois' flaws get drowned out by his message that Galois was a victim. This message sets the essential direction in which the Galois legend would next travel.

⁴⁸ Sarton, p. 243.

⁴⁹ Alexander, p. 99.

⁵⁰ Sarton, p. 247.

⁵¹ Rothman p. 87: "Recently, however, René Taton has discovered a letter of Cauchy in the Academy archives which conclusively proves that he did not lose Galois's memoirs."

⁵² Sarton, p. 252.

⁵³ Sarton, p. 249.

⁵⁴ Sarton, p. 250.

The man who picked up after Sarton was historian of mathematics and science fiction writer E. T. Bell. In 1937, Bell wrote the most famous English biography of Galois in his book *Men of Mathematics*; as a result of its fame, it was also the biography that spread the most myths. In summary, Bell omitted Sarton's asides that Galois' irreverence and imprudence contributed to his misfortunes. Instead, he blamed all of Galois' troubles on an external, rabidly stupid society that systematically oppressed him.

Bell dedicates his book's twentieth chapter, entitled "Genius and Stupidity,"⁵⁵ to the life of Galois. Already, the theme might be clear. Bell's account is riddled with romantic allusions as it expounds on the binary struggle between Galois' genius and French stupidity. A few lines of the provided chapter summary from the table of contents serve to prove that Bell was concerned less with careful scholarship and more with baselessly ascribing thought, motivation, and character to his vision of Galois. Bell writes, "An all-time world record in stupidity. [...] Examinations as arbiters of genius. Hounded to death by a priest. [...] Absentminded Cauchy again. [...] Patriots rush to the field of honor. [...] Buried like a dog." Aside from a few of Galois' letters, Bell cites few sources, one of the only examples being the "classic account by P. Dupuy in the *Annales scientifiques de l'École normale supérieure* (3me série, tome 13, 1896), and the edited notes by Jules Tannery."⁵⁶

Despite citing Dupuy, Bell ignores many facts and twists others to craft yet another spin on the narrative. For example (this is Rothman's prime example), Bell describes Louis-le-Grand as a "dismal horror" that "looked like a prison and was."⁵⁷ Dupuy says the same, except he also says that the prison-like image was due to grilles on the windows, and that the school also had "passions of work" and "academic triumph." As Rothman explains, "Bell, by cutting Dupuy's sentence in half, has begun the slant toward the negative."⁵⁸

Bell's errors and omissions mount as his narrative continues. While it is legend that Galois threw an eraser at his examiner for his second interview to enter the Polytechnique, "Bell records this as fact" despite Dupuy "specifically [stating] that it is only an unverified tradition."⁵⁹ Bell gets a pass for saying that Cauchy lost Galois' first manuscript because evidence to the contrary hadn't yet been discovered,⁶⁰ but there is no excuse for how he mangled Galois' political motivations. In particular, Bell's vision of Galois as only a victim to "negligence, misunderstanding, and bad luck"⁶¹ simply doesn't hold after Galois begins to act on his political convictions. Despite this, Bell makes every effort to make it seem that way.

One of his efforts, an impardonable distortion, is a "wholesale reordering of events."⁶² The reordering is necessary because Bell wants to paint Galois' political actions as a last resort that

⁵⁵ The sixteenth chapter recounts the life of Niels Henrik Abel, who mostly lived concurrently with Galois and who worked on similar problems. Its title is "Genius and Poverty," so Bell may have been going for parallel structure by calling Galois' chapter "Genius and Stupidity." Nonetheless, the theme of stupidity in the twentieth chapter runs far deeper than the title.

⁵⁶ Bell, preface to *Men of Mathematics*, p. v.

⁵⁷ Bell, p. 363.

⁵⁸ Rothman, p. 86.

⁵⁹ Rothman, p. 88.

⁶⁰ René Taton, "Sur les relations scientifiques d'Augustin Cauchy et d'Evariste Galois," *Revue d'Histoire des Sciences*, 24 (1971), p. 123. Taton discovered the letter proving Cauchy knew of Galois in 1971.

⁶¹ Rothman, p. 89.

⁶² Rothman, p. 89.

he is forced to take by a society that is incapable of recognizing his genius (an amplification of how Sartre presented it). The trouble was merely that this was not true, hence Bell's solution to rework the timeline. Thus, every time Galois takes political action, Bell is sure to motivate it with an impelling tragedy. He claims Galois wrote the blistering letter that got him expelled from l'École normale because he was "unable to endure the humiliation of inaction longer."⁶³ This is a twisted way of saying that Galois joined the fray of his own volition. Bell claims Galois joined the Artillery of the National Guard because he found no students for his January mathematics class. This is false; a number of his friends showed up at first, and more pressingly Galois joined the Artillery before January when he held his class. Bell mentions that the Artillery was composed mostly of members of the Society of the Friends of the People, but he forgets to mention that Galois was a member of the radical society too! Bell uses phrases such as "this was the last straw" to again place Galois as a victim.⁶⁴ Sprinkling in Galois' politics here, erasing it there, and always placing it where it serves Bell's narrative results in a fantastical timeline from July of 1830 until May of 1831.

Bell picks up again in May at least with the correct dates, but the story he presents is still consciously and unconsciously manipulated. Even introducing the May banquet in which Galois toasts Louis-Phillipe with an open knife, Bell begins with misinformation. He says that the banquet was held to "protest against the royal order disbanding the artillery which Galois had joined"⁶⁵ rather than to celebrate the nineteen acquitted republicans. After Galois raises his toast, Bell errs again with a mistranslation of the French this time. Basing his descriptions on Dupuy, he writes that "a friend of Galois, seeing the great Alexander Dumas and other notables *passing by the open windows*, implored Galois to sit down" (my italics). According to Rothman, in this context "*Dumas et quelques autres passaient par le fenêtre dans le jardin pour ne pas se compromettre...*" means that Dumas and others *jumped out of the window in order to not be compromised*.⁶⁶ The meaning is completely different. In one, Dumas attends the banquet; in the other, Dumas is a watchful informer at risk of noticing Galois' toast. Rothman claims Bell's errors here cannot be mere carelessness. Instead, they must be an intentional effort to add revolutionary character to the banquet.

Bell's description of Galois' subsequent trial and acquittal are adequate if slightly simplistic, but his bias is glaring when he explains Galois' second arrest on Bastille Day, July 14. He begins by claiming that "Galois [...] was locked up *on no charge whatever*," before giving the reasons for his arrest but dismissing them with a handwave: "True, he had been armed to the teeth when arrested, but he had not resisted arrest," and "Galois was guilty of illegally wearing a uniform."⁶⁷ In the same paragraph, Bell imagines the thought-process of nebulous "authorities" as they work at "trumping up a charge." He uses diction of "them" versus "Galois" to build a dichotomous image of an oppressive, unprovoked government arresting an innocent Galois. Of course, wearing the uniform truly was illegal; Galois was armed with a loaded rifle, pistols, and his dagger; and the "celebration" Galois was heading to was a republican demonstration on Bastille

⁶³ Bell, p. 372

⁶⁴ Bell, p. 372.

⁶⁵ Bell, p. 372.

⁶⁶ Rothman, p. 92.

⁶⁷ Bell, p. 378.

Day. And, as Rothman said, it all happened in a very uncertain Paris, one year after violent revolution, in which “street riots were rampant, assassination attempts not uncommon, and republican activity dangerous.”⁶⁸ Again, Bell has hallucinated motivation for the Paris police and, as always, written Galois as the victim.

Bell’s account of Galois in prison also follows the pattern of omitting key details. Importantly, for example, Bell never mentions Galois’ drunken lament of his lost father. After all, to do so would make Bell’s protagonist too human, giving too many reasons aside from victimhood for his earlier actions. Bell does say how Galois drank brandy once in prison, but “the really important parts of the episode [...] are omitted altogether.”⁶⁹

Bell also repeats Dupuy’s and Sarton’s theme of two worlds -- pure mathematics and crass reality -- that Galois is split between. Bell creates the division in two ways. He imagines a comment that goads Galois to drink the brandy: “What! You drink only water? Quit the Republican Party and go back to your mathematics.” In the comment, Bell sets politics and mathematics as opposites. The second way he creates a division is by quoting Galois himself when he wrote “How can a world which I detest defile me?”⁷⁰ The division between purity and reality feeds into the mythic flavor that Bell’s story takes on more than any biography before it. The contrast of the two worlds also elevates Galois to mythic status, and it makes him seem all the more the victim. Now, not only is Galois the prey of oppressive fools, but even the world into which he was born is not fit for him. One last part of Bell’s story adds the final touch to his fledgling legend: the duel.

Conscious of it or not, Bell misinterprets his sources twice when describing Galois’ last days. First, as the reason for the duel, he writes, “Extracts from two letters suggest what is usually accepted as the truth: Galois had run foul of political enemies immediately after his release.”⁷¹ But political enemies were not commonly accepted as the reason for the duel; in fact, Dupuy believed the opposite.⁷² In addition, Galois is explicit in one letter to “forgive those who kill me for they are of good faith,”⁷³ suggesting his opponents were fellow republicans. Rothman also argues beyond this part of Galois’ letter to show that the reasons for the duel were not related to “royalists, a female agent provocateur, a prostitute, or a government conspiracy.” Surprisingly, this is the lesser of Bell’s two misinterpretations. A slight twist in Galois’ final night will turn out to have far more broad effects.

This twist comes in the form of a single, critical sentence that pertains to the letter Galois wrote to Chevalier with a summary of his results. Of the last night, Bell writes:⁷⁴

He had spent the fleeting hours feverishly dashing off his scientific last will and testament, writing against time to glean a few of the great things in his teeming mind before the death which he foresaw could overtake him.

⁶⁸ Rothman, p. 94.

⁶⁹ Rothman, p. 95.

⁷⁰ Bell, p. 374.

⁷¹ Bell, p. 375.

⁷² Rothman, p. 98.

⁷³ Rothman, p. 97.

⁷⁴ Bell, p. 375.

Contrast this to Sarton's version:⁷⁵

The last letter addressed to his friend, Auguste Chevalier, was a sort of scientific testament. Its seven pages, hastily written, dated at both ends, contain a summary of the discoveries which he had been unable to develop.

It is unclear whether Bell read Sarton, but regardless the resemblance is clear and relevant. There are key differences, however. Specifically, by using the word "glean," Bell implies that Galois was extracting new information from his mind, in other words, that what Galois wrote on the final night was original. This is incorrect; as Sarton stated, the letter was a "summary" of his previous discoveries. Second, Bell writes "scientific last will and testament" where Sarton writes "a sort of scientific testament." The removal of "a sort of" implies that the letter was Galois' attempt to bring new knowledge into the world, rather than a compendium of what he had already written. After all, Galois had at this point written multiple memoirs outlining similar results. Bell caps off the image with Galois working against the clock: "Time after time he broke off to scribble in the margin 'I have not time; I have not time,' and passed on to the next frantically scrawled outline."⁷⁶ In reality, Galois "penned this famous inscription only once during the course of the night."⁷⁷ It appeared after Galois wrote, "There are a few things left to be completed in this proof," and it appeared before a parenthetical, "(Author's note.)" All this tarnishes the glory a little too much for Bell to include it.

Returning to a bird's eye view of Bell, the transformation he completed was to remove all volition from Galois. According to Bell, Galois was but a well-meaning boy with the gift of genius, mercilessly rejected again and again by intellectual inferiors. His political activity was a last resort, forced upon him by the negligent academy. Nowhere to be found was "the quarrelsome and unstable young man known to Sophie Germain," nor the young man who drove his mother out of her house on to the streets. In his place treaded "Galois the martyred innocent, the true genius who through his sufferings had become the patron saint of mathematics."⁷⁸ The human was gone, the apotheosis complete.

What is safe to now call the Galois legend deeply influenced many rising mathematicians. Famous physicist Freeman Dyson once wrote that in his childhood "his head was full of the romantic prose of E. T. Bell's *Men of Mathematics* [...]. It has awakened many people of my generation to the beauties of mathematics. The most memorable chapter [was] called 'Genius and Stupidity.'⁷⁹ Two other scientists in particular joined in after Bell to add their own spins to Galois' life. These were English astronomer Fred Hoyle and Polish physicist Leopold Infeld. Both, following in Bell's footsteps, "invoked a political cause for the duel, with a mysterious coquette just off center."⁸⁰

⁷⁵ Sarton, p. 255.

⁷⁶ Bell, p. 375.

⁷⁷ Rothman, p. 103.

⁷⁸ Alexander, p. 102.

⁷⁹ Freeman Dyson, *Disturbing the Universe* (New York: Harper and Row, 1979), p. 14.

⁸⁰ Rothman, p. 84.

Hoyle in his 1976 book *Ten Faces of the Universe* argues that Galois' tendency to work math problems in his head during his last six months in prison caused his republican friends to think him alien and ultimately believe he was an agent working against them. In response, Rothman asks incredulously how any republican could doubt Galois' faithfulness after "his expulsion from l'École Normale, his Artillery activities, his threat to the King, his arrests, trials, sentencings, resentencings, and prison activities."⁸¹ Not to mention, but more than two thousand republicans attended Galois' funeral. Hoyle's theory is unsubstantiated.

Infeld in his 1948 biography *Whom the Gods Love* argues that Galois' duel was a conspiracy by the government to rid itself of one of the most dangerous republicans in the city; a female provocateur incensed him into the duel, etc. Much evidence contradicts this. First, of course, after Infeld wrote his biography, the identity of the mysterious coquette was resolved as Stéphanie du Motel. The daughter of a physician is an unlikely government-sent provocateur. Moreover, Infeld argues that the assassination attempt that Galois witnessed in prison was actually a bullet meant for him. Rothman asks, "Why Galois over Raspail?" Also, why kill Galois by "firing into a room containing an unknown number of men" at night in a prison on the verge of a riot?⁸² Rothman adds that Infeld, when quoting Galois' drunken pleas to Raspail, skips over the prophecy that Galois will die in a duel. Infeld also omits Galois' suicide attempt. In short, Infeld "publishes any document or any portion of a document which does not interfere with his stated hypothesis that Galois was killed by the secret police."⁸³ The proper way to do history is to research with the intent of forming or disproving a hypothesis; it is after a theory stands the tests of multiple attempts to refute it that it may be accepted as close to the truth, not after it is superficially supported by cherry picking evidence. Thus, Infeld's theory may be discarded.

So far, the trend in biographies since 1921 has been toward erecting a mythic Galois. The trend in evidence has been to omit, twist, or use selectively. The trend in theme has been to degrade reality and supersede it with fantasy. Yet even in this second Era of retellings, there are hints of more careful scholarship to come. The definitive 1962 edition of Bourgne and Azra, for example, "contains every scrap of paper known to have been written by Galois, an accurate chronology, facsimiles of some of his original manuscripts, and a number of relevant letters by others."⁸⁴ In 1968, the scholar Infantozzi managed to discern the identity of Stéphanie du Motel after cleverly using a magnifying glass on some of Galois' original letters, which let him make out du Motel's signature despite Galois having violently crossed it out before.⁸⁵ Still, Bell's narrative reigned. His Galois of legend was the one taught in university mathematics courses and in footnotes to textbooks of Galois Theory. It would take a hundred and fifty years after Galois' death for Bell's narrative to get dethroned.

ERA 3: The Realists (1982 - present)

⁸¹ Rothman, p. 100.

⁸² Rothman, p. 96.

⁸³ Rothman, p. 95.

⁸⁴ Rothman, p. 85.

⁸⁵ C. A. Infantozzi, "Sur la mort d'Evariste Galois," *Revue d'Histoire des Sciences*, 21 (1968), p. 157.

The year was 1982 when American physicist and science fiction writer Tony Rothman published an article in the *American Mathematical Monthly* titled “Genius and Biographers: the Fictionalization of Evariste Galois.”

Rothman’s goal is “to show something is wrong” with the story of Galois’ life.⁸⁶ As he details in his 23 page article, the Galois legend grew over time as successive biographers performed faulty historical analyses, bent on proving their own fanciful theories. Rothman pins the majority of the blame on E. T. Bell’s account in *Men of Mathematics* because of the book’s wide circulation. Rothman also debunks or at least seriously qualifies the theories promoted by other Galois biographers such as Hoyle and Infeld, with reserved comments for Dupuy as well. For example, Rothman suggests it is highly unlikely that Galois’ death was a political assassination or that the duel was fought over a prostitute, and impossible that Cauchy never examined Galois’ first submitted manuscript or that Galois discovered group theory the night before his death. Rothman cites all manner of previous works and primary sources, and he often comments on the validity and context of the sources he cites. Thus, Rothman is far more conscious than most previous authors of how to be historically rigorous. As a result, he is a more reliable source for events of Galois’ life than other biographers before him (although he says Bourgne and Azra are reliable, too).

In true historian character, Rothman also suggests paths for future investigation. He recommends to investigate the identity of Galois’ duel opponent, to find letters written by Stéphanie or her husband, or to search in Raspail’s correspondences. “These avenues are still open for those who are interested,” Rothman writes. “They have been neglected only because of the intentional or unintentional omission of information by those who have previously written on Galois.”⁸⁷

Rothman’s work was foundational, a cornerstone even to this essay. After Rothman first cleared the way in 1982, however, many other scholars have begun to follow in his wake. In fact, almost all professionally published documents relating to Galois since 1982 cite Rothman. This reversal shows the power of careful scholarship. Two authors in particular have picked up the torch in researching Galois.

One is Israeli-American astrophysicist Mario Livio, who investigated Galois to a surprising depth in his 2005 popular science book *The Equation that Couldn’t be Solved*. Livio claimed to “read every document [he] could put his hand on”⁸⁸ in his modern attempt to pick out threads of truth from the Galois legend. He sticks to established facts in the vein of Rothman up to the section on the duel. Here, Livio states boldly that he intends to resolve the mystery. Admitting that he cannot be certain for the lack of solid evidence, Livio nonetheless considers an impressive variety of sources from newspaper articles to letters to the previous work of scholars.

Livio’s central claim is that the pair of combatants who fought Galois were Ernest Armand Duchatelet, a friend of Galois’, and Denis Faultrier, “the close family friend who later married Stephanie’s mother.”⁸⁹ He deduces these identities after discounting political conspiracies by

⁸⁶ Rothman, p. 103.

⁸⁷ Rothman, p. 102.

⁸⁸ Mario Livio, *The Equation That Couldn't Be Solved: How Mathematical Genius Discovered the Language of Symmetry* (New York: Simon and Schuster, 2005), p. 142.

⁸⁹ Livio, p. 151.

citing Rothman, refuting a new theory proposed in 1996 by Laura Rigatelli in which the duel was “entirely staged,”⁹⁰ and rejecting Alexander Dumas’ original claim that the combatant was Pescheux d’Herbinville. Then, to prove his own theory, Livio relies primarily on the descriptions given by family and friends of the combatants (such as a cousin’s testimony that one was a “so-called fiance”). He also assumes that the combatants were republican friends of Galois’ (described as “patriots” in one of his final three letters). Livio explains his assumptions whenever he agrees with or rejects facts about Galois. His book demonstrates a clear effort to make progress on the mysteries of Galois’ death through sound, historical means.

The other author, perhaps the current leading historian of Galois, is mathematician Peter M. Neuman. His largest contribution addresses his observation that “there has never until now been a systematic English translation”⁹¹ of Galois’ work. Thus, on the two-hundredth anniversary of Galois’ birth, Neumann released a bilingual compilation titled *The Mathematical Writings of Evariste Galois*. His book is further evidence of a modern theme of returning to primary sources, following Rothman. But Neumann’s book is more than a set of translations.

As a secondary goal, it attempts to dispel myths about what Galois really knew. Following Rothman, Neumann begins by clarifying that Galois did not invent group theory the night before his death. Neumann also argues that Galois never proved the alternating group on n letters is simple for $n > 4$ (see the Appendix for more detail). He explains how Galois instead came to his groundbreaking result about the solubility of polynomials without ever resorting to this fact.⁹² Neumann covers new territory here, because Rothman was concerned only with historical events and not the actual mathematics at play. In addition, Neumann attempts to deduce which books Galois read as an early mathematician to discern what might have influenced him.⁹³ Neumann’s scrupulousness goes so far as to include ten pages on different interpretations of French words Galois used, how he will translate them, and a warning to look at the original French because of how word meanings change over two hundred years.⁹⁴

Neumann’s intentional return to primary sources, and his willingness to propose new ideas based on his investigations, is a repeated hallmark of Galois’ modern professional biographers. In scholarly circles, Tony Rothman has reversed the myths spun by Bell and encouraged his followers to stick to primary sources and rigorous historical arguments. Unfortunately, this may not be enough.

Even today, non-professionals continue to propagate falsehoods. For example, the online Encyclopedia Britannica entry on Galois⁹⁵ falls prey to many myths started by E. T. Bell and later dispelled by Rothman. The article wrongly writes, for instance, that Galois’ first submitted entry to the French Academy of Sciences “was lost by Augustin-Louis Cauchy.” The article also seems to cherry pick sources (ignoring Rothman) when it vaguely cites “recent scholarship” to suggest that the duel was “staged and fought to look like a police ambush.”

⁹⁰ Livio, p. 150.

⁹¹ Peter M. Neumann, preface to *The Mathematical Writings of Evariste Galois* (Switzerland: European Mathematical Society, 2011), p. vii.

⁹² Neumann, p. 383-385.

⁹³ Neumann, p. 4-6.

⁹⁴ Neumann, p. 17-27.

⁹⁵ June Barrow-Green and Irving Kaplansky, “Évariste Galois.” Encyclopedia Britannica, accessed 2 April 2020, www.britannica.com/biography/Evariste-Galois.

At the same time, other non-professionals successfully cite Rothman, Neumann, and others to create a balanced, modern presentation. For example, the authors of the Galois web article in the MacTutor History of Mathematics Archive⁹⁶ repeatedly state that the legends surrounding Galois have been embellished over time, opting for a far more conservative approach in their descriptions than Bell. The article says the reason for the duel was not clear, and that the story of Galois writing all he knew of group theory the night before the duel “appears to have been exaggerated.”

The story of Galois, therefore, hangs in the balance. Either the falsehoods and myth-mongering of the past will win out, or careful authors who examine the full historical corpus will make it common knowledge that Galois was flawed and human. Which way the pendulum swings, only time can tell.

ERA 4: The Future

In discussing the future, it is often more illuminating to see a trajectory than to see a single moment. There are two sources in particular that offer a look into the modern movement of Galois’ story.

The first is a scholarly source, the textbook *Galois Theory* by Ian Stewart.⁹⁷ Its historical introduction has been updated four times as new editions of the textbook were released from 1972 until 2015. Most importantly, Stewart edited the historical introduction each time, which clearly reflects a shift from pre-Rothman, overromantized history to post-Neumann history that corrects what it is that Galois really knew.

The evolution is as follows. In the preface to the first edition from 1972, there is no mention of Rothman, who wouldn’t publish until ten years later. The preface to the second edition from 1988, published six years after Rothman published, does not mention Rothman by name. Stewart does write, however, that he updated the historical section “in the light of new findings.”⁹⁸ In the preface to the third edition, written in 2003, Stewart explicitly acknowledges that the story of Galois has been “over-romanticised by many writers, as Rothman has convincingly demonstrated.”⁹⁹ Later, in the preface to the fourth edition from 2015, Stewart says he read Neumann’s *Mathematical Writings of Évariste Galois*.¹⁰⁰ Based on his reading, he added a chapter at the end detailing what mathematics Galois really knew and what theorems he really proved, and how this differs from how Galois Theory is typically presented in university classes.

In the historical preface to the textbook in its most recent edition, Stewart states up front that he relies on Bourgne and Azra, Rothman, and Neumann. Thus, his modern presentation reflects all the cautious scholarship that has gone into humanizing Galois and telling his story neutrally. It includes relevant details such as the acquittal banquet, Galois’ subsequent imprisonment, and a discussion of d’Herbinville versus Duchatalet as possible combatants. In

⁹⁶ J. J. O’Connor and E. F. Robert, “Évariste Galois,” MacTutor History of Mathematics Archive, University of St. Andrews, accessed April 2, mathshistory.st-andrews.ac.uk/Biographies/Galois.

⁹⁷ Ian Nicholas Stewart, *Galois Theory* 4th ed. (United States: CRC Press, 2015).

⁹⁸ Stewart, preface to *Galois Theory*, p. xv.

⁹⁹ Stewart, preface to *Galois Theory*, p. xviii.

¹⁰⁰ Stewart, preface to *Galois Theory*, p. xxi.

short, Stewart has done his homework and produced an account in line with all the progress made in the last half century of Galois' evolving historiography. This proves what might have already been clear: within professional circles, the new understanding of Galois will live on. But the question remains: among non-professionals, are the old myths of Galois lodged too deep to mend?

The second source answers this question, despite or perhaps because of how often it is shunned for its low reputability, for its reliance on non-experts, and for its capacity to spread misinformation. For exactly these reasons, Wikipedia is perfect to analyze the historiography of Galois. Twenty years of records track every last character changed on the article about Galois. Observing its evolution gives unique insight into how scholarly discoveries push their way into a non-professional forum. If there is a falsehood on the Wikipedia article, it is not a reason to steer clear, but rather a bright flag begging further investigation. The page is a case study in shifting stories.

The oldest version of the article¹⁰¹ saved on Wikipedia, from 2001, is uncited, vastly abridged, and contains some minor factual errors. For example, the article states that "his [Galois'] work was not understood until 1843 when Louville reviewed his manuscript." This is very likely not true, as Cauchy planned to present to the Academy about Galois' work during Galois' lifetime before becoming sick that day, missing his presentation, rescheduling, and then forgetting to present Galois' ideas the second time around. But even this earliest form, Wikipedia has nods to the uncertainty around parts of the story. For example, it says, "he *supposedly* fought in order to defend the honor of a woman" (my italics), and "which leads *some* to believe that his death in a duel was set up by the secret police" (again my italics). The entire article is only twelve sentences long.

The page¹⁰² from 12 May 2006 is more developed than the original, yet it still lacks many biographical details. The largest series of rapid changes to the article occurred in the following weeks by the user Stormwyrn. By 23 May 2006, the page¹⁰³ was much more complete in its sequence of events. It details Galois' father's suicide, Galois' entrance into the National Guard, and the recent political history of France in which Galois was so enmeshed. The later version of the article still gives certain romantic embellishments, for example how Galois "found a copy of Adrien Marie Legendre's *Éléments de Géométrie*, which it is said that he read 'like a novel' and mastered at the first reading." Both articles, however, contain the same penultimate paragraph: "Much of the drama surrounding the legend of his death has been attributed more to one source than any other - Eric Temple Bell's *Men of Mathematics*."

Six months later,¹⁰⁴ on 8 October 2006, a user named David Haslam first referenced Mario Livio's book *The Equation that Couldn't be Solved*, which was published a year prior. Three days later,¹⁰⁵ the user Stormwyrn added Livio's primary thesis to the section on the duel, writing, "extant newspaper clippings from only a few days after the duel give a description of his opponent which is inconsistent with d'Herbinville, and more accurately describes one of Galois'

¹⁰¹ Stable link to old version: en.wikipedia.org/w/index.php?title=%C3%89variste_Galois&oldid=249613

¹⁰² Stable link to old version: en.wikipedia.org/w/index.php?title=%C3%89variste_Galois&oldid=52894404

¹⁰³ Stable link to old version: en.wikipedia.org/w/index.php?title=%C3%89variste_Galois&oldid=54658604

¹⁰⁴ Stable link to old version: en.wikipedia.org/w/index.php?title=%C3%89variste_Galois&oldid=80287496

¹⁰⁵ Stable link to old version: en.wikipedia.org/w/index.php?title=%C3%89variste_Galois&oldid=80811928

Republican friends, most probably Ernest Duchatelet.” Livio’s new perspective on the combatants is a primary development in Galois’ history between 2001 and 2020. Through the lens of the ever-evolving Wikipedia page, we see its influence firsthand.

There have been hundreds of minor edits to the article since October 2006 that have added approximately 1,000 words and more than 30 citations. The major biographical content, however, remains the same.

As of 14 April 2020, the page¹⁰⁶ contains an accurate, if somewhat abridged, account of Galois’ life. For example, the article relegates Galois’ trial and acquittal from the banquet to a single line, and it does the same for his subsequent stay in prison instead of discussing his highly relevant befriending of Raspail, introduction to alcohol, grief over his dead father, witness to a murder attempt, and transfer after the cholera epidemic. Still, the Wikipedia article cites Rothman in addition to many modern sources such as Livio, and this shows in its more reserved, less romantic retelling. For example, when describing Galois’ second failure to enter into the Polytechnique, the article says, “it is undisputed that Galois was more than qualified; however, accounts differ on why he failed. More plausible accounts state ...” Later, the article again demonstrates a cautious, scholarly tone in saying that “the true motives behind the duel are obscure. There has been much speculation as to the reasons behind it.” In all, the current Wikipedia page is not flashy. Nothing it presents is false, but it does contain fewer details than Rothman’s account and thus doesn’t humanize Galois quite as much. Unlike some earlier versions of the article, however, it manages to give a factual and neutral summary of the major events.

The evolution of the Wikipedia page on the life of Galois has been one of adding and removing embellishment. Importantly, as thousands of eyes passed over the page and contributed their own knowledge over the years, the myths about Galois dissipated rather than spread.

It is critical to the future of Galois’s history whether a non-professional source such as Wikipedia improves its telling of Galois’ life over time or allows it to devolve into romance. Seeing that Rothman’s scholarly version can catch on beyond the academic ivory tower is strong evidence that the centuries-long game of telephone that humanity has played with Galois is at last approaching its end. Of course, the game of telephone will continue as long as the fictionalized Galois lives on in dusty copies of Bell or in careless summaries by the Encyclopedia Britannica. The hope is merely that, with time, the garbled signal will grow weaker while the correct story rings louder and ever clearer. Just as Galois’ manuscripts were forgotten after his death until Louville eventually found them again, we must root for truth to win in the end.

Appendix: Mathematical Overview

Throughout the story of Galois lies implicit that his work contained a spark of such astounding originality that it propelled forward humanity’s mathematical thought in a tangible way. In this section, we briefly and nonrigorously cover the contributions Galois made within the historical context of mathematics.

¹⁰⁶ Stable link to old version: en.wikipedia.org/w/index.php?title=%C3%89variste_Galois&oldid=944960526

The story is of solving equations, as students are taught in high school algebra. Recall that an equation has a root when it equals zero at a given point. For a polynomial of degree one, which is a line, simple rearrangement solves for the root in terms of its coefficients. For a polynomial of degree two, the quadratic formula (derived by completing the square) is famous for solving for the roots given the coefficients. Methods for solving quadratics were known as far back as 2000 BCE by the Babylonians. For a polynomial of degree three, however, a general formula remained elusive until Italian mathematician Girolamo Cardano found it in the 1500s. This formula evaded mathematicians for so long because the derivation requires not only a clever substitution, but also a willingness to deal with so-called imaginary numbers. In fact, the name came from the stigma associated with the numbers at the time. There is a progression in mathematics toward acceptance of new number systems, starting from the whole numbers, moving to fractions, then negative numbers,¹⁰⁷ real numbers, and finally complex numbers, and the stigma was so pronounced that mathematicians of the day derided the base unit i as imaginary. Cardano himself tolerated the imaginary numbers in his calculation only so long as they stayed in the derivation and not in the final answer. The final formula is lengthy, taking multiple lines to write down. Soon an explicit formula for the roots of degree 4 polynomials was discovered, a true beast involving so long a sequence of square and cube roots that no sane person would seek to memorize it. The question remained: will the pattern continue? Is there a general formula for the quintic?

For hundreds of years, most mathematicians thought, “Of course it exists. We simply haven’t found it yet, just as it took thousands of years to find a solution to the cubic.” But a seed of doubt grew as the solution remained hidden into the late 1700s. A hint of the truth came when a mathematician named Ruffini published a flawed proof in 1799 that no general formula existed. Mathematicians were quick to spot the error, but the question remained tantalizingly unsolved. Then a serendipitous dual story occurred: Galois on one side and Norwegian mathematician Niels Henrik Abel on the other. In 1824, Abel published what is known today as the Abel-Ruffini Theorem, definitively proving the nonexistence of a general quintic formula.

It is important to distinguish exactly what this means, because otherwise it seems that the question is answered and Galois has no role left to play. The Abel-Ruffini Theorem says there is no single formula that solves all quintics. It does not exclude the chance, for example, of there being two types of quintics, each with its own general solution. It also does not prevent there from being an explicit solution for every individual quintic, and yet no overall formula. Galois’ innovation excludes these possibilities. After Galois, there was no doubt as to when a polynomial’s roots can be expressed in terms of addition, subtraction, multiplication, division, and extraction of n th roots. Galois’ discovery is the crowning achievement of the theory of equations, which is a large part of the topic called algebra in high school.

¹⁰⁷ The stigma around negative numbers still lingered as late as the 1700s. Hence the arrangement of Euler’s famous identity as $e^{(i*\pi)} + 1 = 0$, rather than the more geometrically intuitive $e^{(i*\pi)} = -1$. The second way better conveys that complex exponentiation involves walking around a circle in the complex plane: π is half of the circumference, so walking π around the circle is a 180 degree rotation, taking the base from 1 to -1.

How did he do it? Galois' method relies on an abstraction of number systems. He defined an object called a group,¹⁰⁸ which is a set imbued with an operation of multiplication that obeys four conditions: (1) closure, (2) associativity, (3) existence of an identity element, and (4) existence of inverses. The integers under addition are a group, because (1) any two integers add to make another integer, (2) any three integers satisfy $(a + b) + c = a + (b + c)$, (3) the integer 0 acts as an identity so that $0 + a = a + 0$ always holds, and finally (4) any integer x has an inverse $-x$ such that $x + (-x) = (-x) + x = 0$. By abstracting away all details of a number system except these four core properties, Galois arrived at a general structure that is now at the heart of modern algebra because of its wide applicability in theory and practice.

Galois also studied an object now called a field. A field is like a group but with two operations, addition and multiplication, for which each operation has an identity, inverses, associativity, and closure, and for which the distributive property holds. By starting with the field of rational numbers, Galois Theory conceptualizes a way to extend a base field with the roots of a finite-degree polynomial. These field extensions contain all the roots of the polynomial within a structure now known as a vector space (which is studied extensively in linear algebra). For every polynomial, there is a smallest extension field that contains all the roots of a polynomial. This is called the splitting field of the polynomial, and every finite polynomial has a splitting field.

There are certain functions called automorphisms that are like blenders when applied to field extensions. They hold the base field in place but mix up the positions of all the other elements. Some automorphisms leave more than just the base field in place, however. Any clump of elements in the field left in place is called an invariant of the automorphism. Galois Theory connects groups and fields by defining the Galois group of a polynomial as the group of automorphisms of the polynomial's splitting field that together hold only the rational numbers in place. The fundamental theorem of Galois Theory says that the internal structure of a polynomial's Galois group is an upside-down version of the internal structure of its splitting field. Thus, there is a mirror structure of groups and fields, and there is a calculated dance of automorphisms, which themselves interact with each other in discernible ways.

With this as his foundation, Galois realized that the structure of a polynomial's Galois group determines whether or not the polynomial is solvable. The exact condition comes down to whether the Galois group has a certain chain of smaller groups within it. Due to the tight relationship between the Galois group and the splitting field, this chain captures a property of the field extensions that determines whether it is possible to express the roots of the polynomial in terms of extraction of n th roots.

That is a lot to process. There is a reason many mathematicians describe Galois Theory as one of the most beautiful parts of mathematics. It is the sheer creativity Galois needed to dare to dream of such novel objects and then to be able to wrangle them into place with enough precision to make sweeping statements about the theory of equations -- it is this creativity that evokes awe.

¹⁰⁸ Lest Neumann expose me, I must caution that the explanation given here is not the precise path Galois took, but rather a streamlined, modern presentation.