

Chapter 6: FURTHER INVESTIGATIONS OF THE MIND-BODY PROBLEM

The Kabbalist: Thinking too much can lead to madness.

Don Pedro Velasquez: Reason can accept anything, if it is used knowingly.

from *The Saragossa Manuscript* (1965), film by Wojciech Has

The real lover of learning [philomathes]... will not ...desist from eros until he lays hold of the nature of each thing in itself with [the rational] part of the soul ...drawing near to and having intercourse with the really real.

Plato, *The Republic*, 490b.¹

If, as French film critic Jean Mitry claimed, "a film is a mirror in which we recognize only what we present to it through what it reflects back to us"², do we mathematicians recognize ourselves in the increasingly frequent cinematic images of our profession? When we look in our private mirrors, do we see Carlo Cecchi (*Death of a Neapolitan Mathematician*), Tilda Swinton (*Conceiving Ada*), Matt Damon (*Good Will Hunting*), Gwyneth Paltrow (*Proof*), Russell Crowe (*A Beautiful Mind*), Rachel Weisz (*Agora*), Sean Gullette and Mark Margolis (*Pi*), David Wenham (*The Bank*), or Béatrice Dalle (*Domaine*)? Or perhaps the autistic savants played by Dustin Hoffman (*Rain Man*) and Andrew Miller (*Cube*)? Do we agree that we are misfits (Damon, Hoffman, Miller, Dalle, Wenham) if not martyrs (Weisz, Margolis, Cecchi, Swinton), on the verge of madness (Paltrow, Crowe, Gullette, Cecchi) if not over the edge, and stunningly attractive (nearly everyone)?

Now joining the cast is Edward Frenkel, a Berkeley professor and one of the rare mathematicians who would not look out of place on the red carpet at Cannes, as author, co-director, and star of a 26-minute independent film entitled *Rites of Love and Math*. The action is well summarized by the synopsis included with the film's press packet:

Mathematics is first and foremost pursuit of Absolute Truth and Beauty. This is the story of a Mathematician who has found, after many years of hard work, the ultimate Formula of Love. At first, he was thrilled that his formula would benefit people, bringing them eternal love, youth and happiness. But later he discovered the flip side of the formula: it could become, if used in the wrong way, a weapon against Humanity. And so forces of Evil are now after the Mathematician. They want to take possession of the magic powers of his formula and misuse them in order to achieve their sinister goals. The Mathematician knows that there is no escape for him, and he is ready to die. But he wants his formula to live.

The Mathematician has a secret love affair with a beautiful Japanese woman, Mariko. At midnight, he comes to her place and tells her about his predicament. Having realized that they are seeing each other for the last time, they make love more passionately than ever before. And then the Mathematician tattoos the magic formula on Mariko's body. They both know that this is the last time they are seeing each other. Afterward their love will live in this formula engraved on her beautiful body...

Whenever I hear of a mathematician pursuing extra-professional interests, I am reminded of Levi-Strauss' impressions of São Paulo high society in the 1930s:

Society, being limited in extent, had allocated various roles to its different members. All the occupations, tastes and interests appropriate to contemporary civilization could be found in it, but each was represented by only a single individual... There was the Catholic, the Liberal, the Legitimist and the Communist; or, on another level, the gourmet, the book-collector, the pedigree-dog (or -horse) lover...³

Among contemporary mathematicians one finds the novelist, the ballroom dancer, the dandy, the cultural critic, the theologian. In the last two years Paris has seen a procession of mathematicians from America in novel roles: the installation artist (Dick Gross), the fashion consultant (the late Bill Thurston), the *auteur* (Ed Frenkel) and the sex symbol (Frenkel again).

The more dynamic sectors of the French mathematical establishment — represented by the Fondation de Mathématiques de Paris-Centre, which contributed financially to Frenkel's film, and the Institut Henri Poincaré (IHP), currently directed by the media-friendly Fields Medalist Cédric Villani — have conspicuously welcomed these developments that hint at a kind of glamour to which we are mostly unaccustomed. Although his project suffered neither from corporate sponsorship nor from the support of the mainstream media, turning film-maker has nevertheless brought Frenkel into some scandalous company. Japanese novelist and ultra-nationalist Yukio Mishima, for starters; Frenkel's *Rites* is consciously modeled on Mishima's film *Yūkoku*, also known as *Patriotism* or *The Rite of Love and Death*, "suppressed" by his widow after the author performed *seppuku* in 1970 (according to Wikipedia) until it resurfaced accidentally a few years ago. Through his co-director, the experimental filmmaker Reine Graves, Frenkel was exposed to the psychoanalytic theories of Jacques Lacan — Graves claimed to me that Frenkel had read all of Lacan in a single day — as well as to Graves' former collaborator Jacques Henric, literary contributor to the magazine *Art Press*, which is directed by his companion, the sexual Stakhanovite Catherine Millet, whose *The Sexual Life of Catherine M.* is one of the founding documents of what French weekly magazines a few years ago were calling the "new libertinism." Henric supplied a sort of interpretation for the *Rites* press kit:

There is also a lesser tradition in literature, philosophy and morals, which strives to ease and even bluntly cut the link between Eros and Thanatos. In the course of the XVIII century, French Libertines followed it, but in the XIX century, with the advent of Romanticism [sic], "love to death" came back into fashion, and the past century... did nothing to liberate itself from the influence of this ideology and this moral philosophy. In Japan, on the other hand, a deep-rooted tradition, close in spirit to that of French Libertines, has nourished a grand and steady literary current as well as an essential trend in painting striving to produce the most beautiful images.

Both Mishima's film and its "homage" by Frenkel and Graves are highly stylized and take place on the Noh stage with Wagner's *Tristan* playing in the

background.⁴ Frenkel's Mathematician, played by Frenkel himself, replaces Mishima's army officer who, passionately attached to the emperor as well as to his wife, performs *seppuku* to avoid being forced to attack his equally patriotic comrades-in-arms. We have seen in the synopsis that the Mathematician impales himself on a blade as well. The ritualized suicides take place after no less ritualized scenes of love-making — "love to death" is alive and well in Japan as well as in *Rites* — in front of a scroll painting. In Mishima's film, the scroll reads "Sincerity" in calligraphic Chinese characters; in Frenkel's it reads *Истина* (istina) — Russian for Truth — and though the screen informs us that that "In the face of death, the Mathematician and Mariko bid final farewell to every little detail of each other's body," what Lacan would have called the mathematician's "signifier" remains at all times concealed from the spectator. Here's Henric again:

What has motivated Edward Frenkel and Reine Graves to make their film Rites of Love and Math? Is it to drive not just the nail, but the knife, if one may say so, between spirit and flesh, or is it to finally reconcile them?

Relatively few professions are practiced even intermittently in the nude, and while *Rites* is likely to reopen the long overdue debate on whether mathematics, like the fieldwork for Catherine M.'s memoirs, should be one of them, I find the film most explosively scandalous in its confusion of genres — practically a category mistake — focused precisely on the reconciliation Henric evokes of "spirit and flesh", more classically known as the *mind-body problem*. Archimedes deserved a best supporting role nomination for dramatizing the problem in Plutarch's *Life of Marcellus*:

*...he neglected to eat and drink and took no care of his person; ... he was often carried by force to the baths, and when there he would trace geometrical figures in the ashes of the fire, and **with his finger draws lines upon his body** when it was anointed with oil, being in a state of great ecstasy and divinely possessed by his science. [my emphasis]*

The Archimedes of classical literature embodies a metaphysical paradox. On the one hand, in the Plutarch quotation, as well as in his Eureka! scene — the most persuasive argument to date in favor of mathematical nudity — he created the classic figure of the mathematician distracted to the point of total withdrawal from the material world, reduced to mind alone. The archetype of the absent-minded mathematician was revived during the Enlightenment, as we see below, but is not typical of recent cinematic representations of the profession, and this is perhaps surprising, given that the absent-minded professor is certainly a stock character in popular film. On the other hand, in the familiar anecdotes just recalled, Archimedes's body is literally visible and uncovered; in a third anecdote, also from Plutarch, a Roman soldier's sword severed the spirit from the flesh of the Greek mathematician found in a "transport of study and contemplation" on the beach near Syracuse. Seen from the outside, the mathematician's body is an object of ridicule, inappropriately displayed and in the way. But from the inside the body is irrelevant, at best serving as a convenient surface for the drawing of geometric diagrams, as Mariko's body in Frenkel's film is in the end only a surface for preserving Frenkel's "magic formula"⁵, or as the bodies in Catherine M.'s narrative, not least her own, are little more than machines performing repetitive and largely predictable motions in a variety of natural

and artificial settings.

The scandal of Catherine M. is the "Je" of the first-person narration, told from the viewpoint of one of these machines; the scandal of Archimedes, and of western metaphysics as a whole, is that the mind forever ceases its inventions and discoveries when the body is left in a heap on the sand. An unwritten rule of cinema, especially of erotic cinema, is that not all reminders of materiality are equally painful to behold; in this respect *Rites* is faithful to the tradition. But attempts to transcend our material limitations and to encompass the infinite within our finite bodies lead invariably to swift retribution and martyrdom: expulsion from the Garden of Eden, the fall of Icarus, crucifixion, or the insanity of the mathematicians represented in popular films. The hero of *Pi*, having computed the 216-digit number from which all patterns in nature arise, only escapes martyrdom by voluntarily ridding himself, with the help of a power drill, of the substance responsible for his mathematical understanding, located on the border between spirit and flesh in his right temporal lobe.

Members of the non-specialist public more comfortable with words than images may base their impressions of mathematicians on the biographies, written by distinguished writers and published in Norton's Great Discoveries series, of Cantor, Gödel, and Turing: two madmen and a martyr, all damaged by encounters with infinity. Those who prefer a balance of words and pictures can turn to the graphic novel *Logicomix*, written by Apostolos Doxiadis and Christos Papadimitriou with a team of professional artists: they will learn that the creators of the logical foundations of mathematics, not excluding the consummate rationalist Bertrand Russell, were haunted by madness. Even those who only know what they see on TV have heard about Grigori Perelman, deemed crazy for turning down a million dollar prize after having solved "one of the most difficult problems of the last ten centuries" and reportedly slated to be the subject of a James Cameron film.⁶

Frenkel has explained in a series of press interviews that he wants to "set the record straight" and offer an alternative to the stereotypic image of the mathematician as "the mad scientist" of *Pi* and *A Beautiful Mind*:

*My purpose is precisely to counter these stereotypes. I wanted the mathematician in our film to be seen as a human being with whom the public can relate: he tries to do his best in difficult times, he is someone who can love and be courageous, who fights for his ideals.*⁷

Once in New York City, near *Pi*'s neighborhood, a friend's neighbors, to whom I had been introduced as a mathematician, told me how fortunate they felt to meet someone from such a sensitive profession. In those days, before the dark forces finance mathematics serves had transformed lower Manhattan's sociocultural landscape, it was still possible to be moved by a sentiment expressed so unaffectedly, even by a couple marginally integrated into society who, my friend later told me, practiced domestic violence almost on a daily basis. It was the last time artists acknowledged me without prompting as one of their own, and I thought of them at the champagne reception following the film's first screening, when three of the co-director's friends, sharing a cigarette, insisted in response to my question that they were not at all shocked to see eros and mathematics treated in film as reflections of one another. On the contrary, although their professionally informed comments were

sometimes sharply critical of the lighting, colors, sound, acting — of everything that makes *Rites* a film rather than an idea, in fact — they were in total agreement that Frenkel and Graves had found a "très beau choix de sujet," a "beau thème", in conceiving a film about a mathematician who is simultaneously a lover and a martyr to Truth.

Reading the blogs, one learns that Frenkel's complaint about the treatment of mathematicians in popular culture is widely shared. But in an important sense it's beside the point. Cinema doesn't need to look to mathematics for unstable or unhappy character types. No one complains that films about Sid Vicious, Kurt Cobain, or Jim Morrison reinforce negative stereotypes about rock musicians, and who can keep track of all the cinematic representations of Van Gogh? The interesting question is not whether mathematicians are portrayed as deranged or tormented but in what sense their torment or madness is characteristically mathematical.⁸

Indeed, the madman is only one of the stereotypes on the mathematician's storyboard. According to historian Amir Alexander,

*Among modern mathematicians, it seems, extreme eccentricity, mental illness, and even solitary death are not a matter of random misfortune ...in the popular imagination... mathematicians feature prominently as loners and misfits who never find their place in the world.*⁹

Frenkel's Mathematician is neither a loner nor a misfit, much less a madman, but his death is almost — though not quite — solitary. His film thus reproduces the image of mathematician as *romantic hero*, the stereotype that, for Alexander, has represented mathematics "in the popular imagination" since Galois was elevated to iconic status several decades after his death. Revisiting the lives of Byron, Keats, Shelley, Novalis, and Chopin — he could have added Pushkin and Lermontov — Alexander writes

the romantic hero is a doomed soul whose quest for the sublime leads to loneliness, alienation, and all too often an early death. But in the few years allotted to him, the romantic hero burns more fiercely and shines brighter than any of his fellows... (p. 161)

A familiar picture, to be sure. More surprising is Alexander's report that the romantic details of Galois's biography that have inspired generations of mathematicians — including Frenkel, whose most important work straddles the boundary between Galois theory and mathematical physics — were in large part fabricated in the decades after his death in order to fit Galois into a pre-existing romantic mold.¹⁰ Moreover, according to Alexander, the "troubled mathematical martyr", exemplified not only by Galois but also by Abel, Bolyai, Riemann, Cantor, Gödel, Turing, Nash, Grothendieck, Perelman, and even in a certain sense Cauchy, remains to this day the dominant image of the "ideal mathematician," long after the romantic paradigm was exhausted in the arts.

Perhaps paradoxically, the well-known account of Galois' life is the more important for being false. One sees more clearly that Galois' invented romantic persona fills and thereby reveals a cultural need; unadorned truth is not always up to the task. Alexander sees this persona as constructed in opposition to the

Enlightenment ideal of the mathematician as "natural man." The prototype of this ideal, with its obvious echoes of Rousseau, was D'Alembert, especially as represented by Condorcet in his eulogy of the encyclopedist at the Académie Française: another fabrication, as Alexander makes clear. A semi-fictional D'Alembert was made to play the natural man as "disconnected dreamer and hopeless bumbler" in Diderot's *D'Alembert's Dream*. A more complete and well-rounded fictional interpretation of the mathematician as natural man is provided by the "geometer" Don Pedro Velasquez of Jan Potocki's late enlightenment novel *The Saragossa Manuscript*. Distracted, like Archimedes¹¹, to the point of walking into a stream while engrossed in his calculations, Velasquez is nonetheless noble and elegant, an engaging storyteller, an enlightened philosopher, and, most importantly for our purposes, an object of romantic interest.

In this respect Velasquez was a mathematician of his time. The Oxford English Dictionary informs us that in 1750 "The Wranglers" — top ranked candidates in the mathematical tripos at Cambridge University — "usually expected, that all the young Ladies of their Acquaintance... should wish them Joy of their Honours."¹² In their obituary dedicated to the analyst and geometer Alexis Clairaut, Diderot and Grimm described the mid 18th century mathematical craze:

Clairaut avait vu ce règne brillant de la géométrie, où toutes nos femmes brillantes de la cour et de la ville voulaient avoir un géomètre à leur suite. (Clairaut had witnessed the illustrious reign of geometry, when all our brilliant women of the court and the city wanted to have a geometer at their disposal.)¹³

Clairaut, who, according to Diderot and Grimm, "aimait éperdument le plaisir et les femmes" may have been the first mathematician to propose a love equation in the form of the Archimedean spiral, "on which the Geometers have so greatly exerted themselves, without having discovered its true nature."

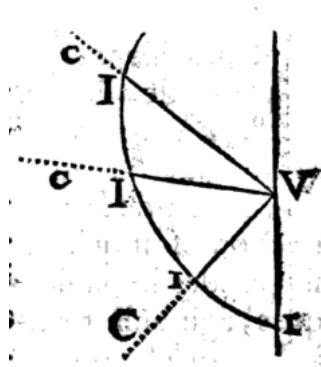


Figure 6.1. Clairaut's love equation, circa 1745. V is the fixed fulcrum and the i's and I's moving clockwise represent the motion of its endpoint.

On demande la Courbe iiI décrite par l'extrémité d'un corps Vi, qui étant d'abord dans une situation verticale renversée Vi, change ensuite de grandeur & de position en devenant successivement Vi VI, &c. (We seek the curve described by the endpoint of a body, initially vertical and pointing downward, that subsequently changes in length and

position.)¹⁴

Enlightenment mathematicians were more likely than not to be erotically curious. In his speculation on life on other worlds, Fontenelle claimed that "*les raisonnements de mathématique sont faits comme l'amour*"; "*Ces deux sortes de gens-là [mathematicians and lovers] prennent toujours plus qu'on ne leur donne.*" Maupertuis' thoughts¹⁵ on evolution begins with a vivid depiction of the role of pleasure in the preservation of species not unlike the "rites of love" that occupy the middle of Frenkel's film:

Celle qui l'a charmé s'enflamme du même feu dont il brûle : elle se rend, elle se livre à ses transports ; et l'amant heureux parcourt avec rapidité toutes les beautés qui l'ont ébloui : il est déjà parvenu à l'endroit le plus délicieux... (La Venus Physique)

And Potocki, a soldier and adventurer in his early life, has the beautiful and cultivated Rebecca of his novel, in the course of her extended flirtation with Velasquez, ask the geometer where love fits in his system:

Mais, dit Rébecca, ce mouvement que l'on appelle amour, peut-il être soumis au calcul? (But, said Rebecca, this movement we call love, can it be calculated?)

Here on the 20th day of the narrative¹⁶ Rebecca is concerned with the tendency of a man's love to diminish with intimacy while the woman's increases; Velasquez replies that there must therefore be an instant when the two love equally, and adds "I have found a very elegant proof for all problems of this kind: let X..."

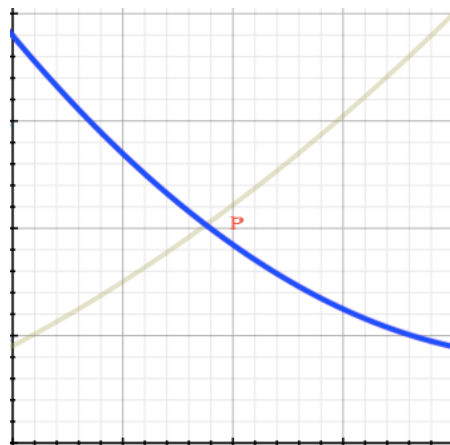


Figure 6.2. Illustration of Don Pedro Velasquez' Intermediate Love Theorem. The blue curve measures the decline of the man's love, the beige curve the increase of the woman's. The point P is the intersection predicted by Velasquez. Potocki unfortunately does not allow his character to present the proof.

On the 33rd day Rebecca and Velasquez return to the question with the latter recasting the question in terms of positive and negative numbers:

...si je hais la haine de la haine, je rentre dans les sentiments opposés

à l'amour, c'est-à-dire dans les valeurs négatives, tout de même que les cube de moins est moins. (...if I hate the hatred of hatred, I return to the feelings opposed to love, that is to negative values, just as the cube of minus is minus.)

After several paragraphs of this, Rebecca, now called Laure, interrupts Velasquez:

...si je vous ai bien compris, l'amour ne saurait être mieux représenté que par le développement des puissances de X moins A beaucoup moindre que X.

Aimable Laure, dit Velasquez, vous avez lu dans ma pensée. Oui, charmante personne, la formule du binôme inventée par le chevalier don Newton doit être notre guide dans l'étude du coeur humain comme dans tous les calculs.

[...if I have understood you, love is best represented as the development of powers of X minus an A that is much smaller than X. Dear Laure, said Velasquez, you have read my mind. Yes, charming person, the binomial formula invented by the knight Don Newton must be our guide in the study of the human heart as in all calculations.]

I agree with you quite upon Mathematics too - and must be content to admire them at an incomprehensible distance - always adding them to the catalogue of my regrets - I know that two and two make four - and should be glad to prove it too if I could - though I must say if by any sort of process I could convert two and two into five it would give me much greater pleasure ... (Lord Byron to his wife)

Leading mathematicians grew increasingly intimate with power as the Enlightenment waned in the last decades of the eighteenth and first of the nineteenth centuries, and mathematics was prized as a source of charisma. The artillery specialist Choderlos de Laclos, for example, was trained in ballistics — as a mathematician, in other words — before he became known as author of the classic libertine novel *Les Liaisons dangereuses*. "Even more than their [Enlightenment] predecessors", writes Alexander, Monge, Laplace, Carnot, and Fourier were "men of action, high officials of state under the revolutionary regime and Napoleon, and personal friends of the greatest men of the realm" (*Duel at Dawn*, p. 74). And "for [the young Stendhal], at least, mathematics was ... the royal road to Paris, glory, high society, women."¹⁷

Readers are nevertheless advised to contain their excitement a bit longer. Since the French revolution literary attitudes toward mathematics have been marked by rejection or indifference, as indicated by the Byron quotation above.¹⁸ When Zamyatin's protagonist D-503 in *We* asks "*Can I find a formula to express that whirlwind which sweeps out of my soul everything save [his opposite number, the sensual I-330]... when her lips touch mine*",¹⁹ the author clearly wants us to answer: No, there is no formula. Psychoanalysts did occasionally resort to diagrammatic representations of love, as in Jung's representation of the archetype of the "marriage quaternio":

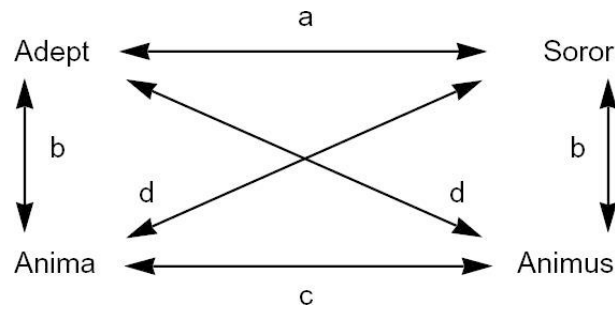


Figure 6.3. Jung's "marriage quaternio"

There have also been bursts of enthusiasm in France. The writer Isidore Isou, who founded Lettrism shortly after the second world war and wrote a theoretical and practical study of the "mechanics of women" as well a treatise entitled *Traité d'érotologie mathématique et infinitésimale*, devoted a number of texts to formulas for love, including the one illustrated in Figure 6.4.

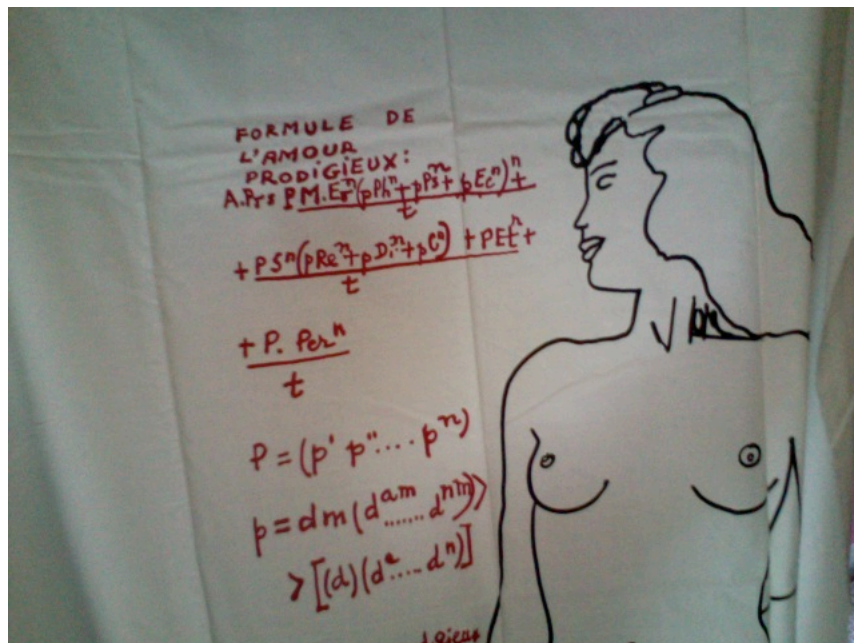


Figure 6.4. *Formule de l'amour prodigieux*, copyright Cathérine Goldstein. I thank her for bringing this image to my attention and for authorizing its reproduction. The formula is accompanied by a legend: A.Pr = *amour prodigieux*, P = total perfection, p = partial perfection, Per = perversion, D = discussion, M.Er = erotic mechanics, t = time, and so on.

Existentialists were more ambivalent, but I have heard of an incident in which one of them *caressed* the monographs of a well-known mathematician, "the only kind of books they could not understand at all." Undeterred by their occasional lack of understanding, but deeply influenced by the Bourbaki group's insistence on the centrality of *structures* in mathematics, the structuralist generation in France had meanwhile placed mathematical models at the center of their philosophy, with Claude Lévi-Strauss going so far as to include a chapter on group theory by André Weil in his *Elementary Structures of Kinship*.²⁰ Weil, by the way, wrote author what must be the single most often quoted account of mathematical discovery in an erotic vein:

*...around 1820, mathematicians (Gauss, Abel, Galois, Jacobi) permitted themselves, with anxiety and delight, to be guided by the analogy [between an algebraic and a geometric theory] ... [Now] gone are the two theories, their conflicts and their delicious reciprocal reflections, their furtive caresses, their inexplicable quarrels; alas, all is just one theory, whose majestic beauty can no longer excite us. Nothing is more fecund than these slightly adulterous relationships; nothing gives greater pleasure to the connoisseur, whether he participates in it, or even if he is an historian contemplating it retrospectively...*²¹

Among the structuralists, responsibility for love, by way of psychoanalysis, fell to Jacques Lacan, and a flourishing collaboration in Lacanian knot theory remains active at the margins of French mathematics and psychoanalysis. In most of Lacan's seminars mathematical symbolism made only a fleeting appearance, as in this excerpt, which I will not attempt to translate, from his seminar in Vincennes December 3, 1969²²

JACQUES LACAN – (*se tournant vers le tableau*). Ça c'est une suite, une suite algébrique...

INTERVENTION – L'homme ne peut pas se résoudre en équation.

JACQUES LACAN –... qui se tient à constituer une chaîne dont le départ est dans cette formule :

S2 a s S S1 S S a

Some of the terms in the "algebraic" formula may refer to the poles in the diagram (Figure 6.5) of the "mirror stage," a version of the all-purpose structuralist double binary opposition scheme and the starting point for Lacan's approach to the mind-body problem, in which "the child anticipates the mastery of his bodily unity by an identification to the image of his likeness and by the perception of his image in a mirror."²³

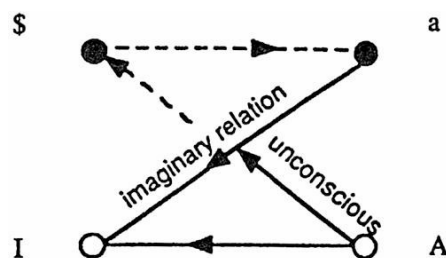


Figure 6.5.

More recently, French philosopher Alain Badiou has attempted to place Lacan's theory of love on a sound theoretical footing. I am indebted to Vladimir Tasić for drawing my attention to this excerpt from a discussion of Badiou's *La Scene du Deux*. UC Irvine professor Juliet Flower MacCannell writes²⁴ that "Badiou has succeeded. He has formalized—to an unparalleled degree—the work of the [Lacanian] object 'a' [the upper right corner of the diagram, MH] in structuring the nonrelation of the sexes and opening the way to the relation that is in excess over

them: the supplement of Love." MacCannell quotes Badiou (her translation):

An amorous encounter is that which attributes eventmentally to the intersection—atomic and unanalyzable—of the two sexed positions a double function. That of the object, where a desire finds its cause, and that of a point from which the two is counted, thereby initiating a shared investigation of the universe. Everything depends, at bottom, on this $u \leq M$ and $u \leq W$ being read in a double fashion: either that one is assembling there the inaugural non-relation of M and W , inasmuch it affects the non-analyzable u with being only what circulates in the non-relation. The positions M and W are then only in this misunderstanding over the atom u , cause of their common desire, a misunderstanding that nothing sayable can lift off, since u is unanalyzable. This the first reading. Or one reads it in the other direction: starting from u , either $(W - u)$ and $(M - u)$, two positions like those the atom u supports by subtracting itself from it. (pp 186-7 of Badiou's original text).

Tasić made the following attempt at an interpretation²⁵:

The sexes (M and W) are not in a relation but both dominate the same atom (u) in some poset. Apparently the successful solution of Lacan's riddle ("there is no sexual relation") is a love formula having something to do with the notion of a partially (but not totally) ordered set.

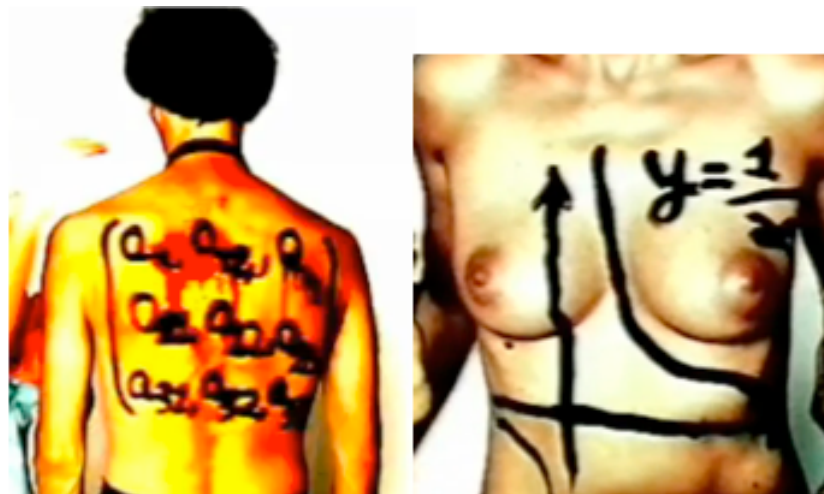


Figure 6.6. His and hers matching love formulas: from the short film *Riducimi in forma canonica* (Reduce me to canonical form) by Monica Petracci, 2000.

Interviewed by *Daily Californian* reporter Samantha Strimling, Frenkel explained "he wanted to challenge the notion of what mathematicians can do" by following Mishima and including a sex scene in *Rites*.

"How about this: We have a mathematician ... who is fighting for his ideas, and he is in love and there is actually a nude scene. He is actually making love to a beautiful woman," [Frenkel] said. "How about that compared to the stereotypes people are used to?"

I'm not sure I've ever met a professor other than Frenkel, in any specialty, at any university, who has submitted the surface of his or her body to public inspection in quite this way.²⁶ But we have seen that the fashionable public of Diderot's time had no doubts about "what mathematicians can do." It is ironic that the rise of the romantic image of the mathematician coincides with the end of the image of the mathematician as a model romantic partner. George Sand had a full register of romantic men *à sa suite*, but none of them was a mathematician. Lord Byron's daughter Ada, in contrast, was encouraged by her mother to study mathematics expressly in order to protect her from her father's romantic madness.²⁷ Every mathematician knows that Galois was killed in a duel over a woman — sometimes identified as "Stéphanie" — but Alexander argues that "the affair, such as it was, did not go well, and [...] Stéphanie was trying to distance herself from the intense young mathematician."

Galois' death, for Alexander, was the culmination of a pattern of arrogant and self-destructive behavior rationalized as uncompromising devotion to the truth. In the letter he addressed "to all republicans" on the eve of his death, Galois can only "repent having told a baneful truth to men who were so little able to listen to it calmly... I take with me to the grave a conscience clear of lies."²⁸ Alexander argues that the transition from the Enlightenment to the romantic ideal in the lives of mathematicians parallels a transformation of the subject matter. "...[T]he new mathematicians turned away from the Enlightenment focus on analyzing the natural world to create their own higher reality—a land of truth and beauty governed solely by the purest mathematical laws."²⁹ In his own mind, and in the legend that grew up around his life, Galois died for the sake of what *Rites'* synopsis called "Absolute Truth and Beauty", just as Frenkel's Mathematician died for *istina*. But where "[the romantic], whether poet, artist, or mathematician... was ... an otherworldly creature who belonged in a better and truer world than ours" (*ibid.*), the Mathematician of *Rites* devotes his life's work to discovering a "Formula of Love" that "would benefit people, bringing them eternal love, youth and happiness."³⁰ Is Frenkel's Mathematician's romantic martyrdom for truth in contradiction with his materialist objectives, like the Enlightenment practitioners of mathematics as a "science of the world that had its roots planted firmly in material reality"?³¹ Or do Frenkel and Graves agree with the Russian mathematician A. N. Parshin who wrote, referring to the mathematics of elementary particles, that "*The deeper we plunge into the material world, the further we move from it in the direction of the ideal world*"?³²

Hal: [...] Mathematicians are insane. I went to this conference [...] last fall. I'm young, right? I'm in shape. I thought I could hang out with the big boys. Wrong. I've never been so exhausted in my life. Forty-eight straight hours of partying, drinking, drugs, papers, lectures...

Catherine: Drugs?

Hal: Yeah. Amphetamines mostly.[...] Some of the older guys are really hooked. [...] They think math's a young man's game. Speed keeps them racing, makes them feel sharp. There's this fear that your creativity peaks around twenty-three and it's all downhill from there. Once you hit fifty it's over, you might as well teach high school. (From *Proof*, cited by K. H. Hoffmann in *Notices of the AMS*)

A totally unfounded fantasy, and if you were expecting any serious gossip at this point I'm afraid you're going to be disappointed. On the contrary, there seems to be a growing consensus that, in spite of the persistent public fascination with mathematics, it's not among mathematicians that you'll find the best parties, and that

life is more fun in the company of dancers, philosophers (Anglo-American or continental), hedge fund managers, fashion designers, biomedical engineers, theater critics and/or performers, historians, industrialists, Russian Orthodox theologians, or anyone involved with the movies. In the new world of public-private partnerships, leading European research institutions are also encouraged to follow the dark side into its realm of dream and magic. Consorting with the men and women at the summit of the socioeconomic firmament is consistent with the injunction raining down on us from all quarters to tie our work more closely to the needs of production, especially the production of wealth. The culture industry, meanwhile, deals primarily in the production of novelty, and indications are that mathematics' added value has yet to be exhausted. Aronovsky's *Pi*, whose plot is driven by Wall Street's search for a formula to predict the future course of stock prices, stands as a reminder that the "forces of Evil" will not invest in our work without expecting a substantial return. When a mathematical community still largely faithful to the romantic ideal crosses paths with the masterminds of enlightened materialist ruthlessness, will the result be a second Enlightenment mind-body synthesis, a Faustian bargain signaling a renewed appreciation of one another's desirability, with the "brilliant women of the court" replaced in the updated version by shapers of taste and prophets of economic competition, and with the reflection on human freedom of a Rousseau or a Condorcet replaced by obsessive attention to the bottom line?

In recent years, mathematics has made its mark on the inexhaustible witches' sabbath that is Paris nightlife. Harvard mathematician Dick Gross passed through Paris in the fall of 2008 for the opening of his collaborative installation with multimedia artist Ryoji Ikeda at *Le Laboratoire*, a "[n]ew creative space" near the French Ministry of Culture "dedicated to experimental collaboration between artists and scientists," directed by the author and biomedical engineer David Edwards. After exchanging messages for a year on "mathematics, infinity, the sublime,"³³ Gross and Ikeda settled on an installation of two horizontal monoliths, each covered with more than seven million tiny digits representing in one case a prime number, in the other a "random" number.

Biomedical engineers have the edge on parties, if the opening reception at *Le Laboratoire* is any indication. Wandering across the dimly lit exhibition space — the two numbers were illuminated from above and their digits could only be inspected with the help of a magnifying glass — the few mathematicians in attendance, Ed Frenkel and I among them, gradually found one another in a crowd of hundreds of the experimental collaboration's boisterous and relentlessly stylish celebrants. An office door slid open before us and we were ushered in to join the collaborators. While Edwards fiddled with a magnum of VIP champagne, Ikeda dropped to his knees at the feet of Jean-Pierre Serre and announced, "For me you are a rock star!"

Parisian mathematics had no official representation at *Le Laboratoire* but was in evidence at the March 2010 opening of another Japanese-American collaboration, this time between the late topologist Bill Thurston and Dai Fujiwara, creative director for the Issey Miyake fashion house.



Figure 6.7. Thurston and assistant wrapping Dai Fujiwara in a knot (my photo); still from http://www.isseymiyake.com/isseymiyake_women/

*[Y]ou did not need a top grade in math to understand the fundamentals of this thought-provoking Issey Miyake show...*³⁴

Fujiwara had contacted Thurston after learning about Thurston's Geometrization Conjecture and its connection with the Poincaré Conjecture. Fashion designer and mathematician, it turned out, both used the peeling of an orange to help their students understand geometry. "We are both trying to grasp the world in three dimensions," Thurston told the AP. "Under the surface, we struggle with the same issue."³⁵

Alerted by a message from IHP director and recent Fields medalist Cédric Villani (whose own fashion statements favor a 19th century romanticism), my colleagues and I arrived in time to talk to Thurston before his performance,³⁶ to sample the hors-d'oeuvres (American and topological: doughnuts, pretzels, bagels), and to register the shocked expressions of the insiders, too spontaneous to be concealed, as they witnessed the breaching of a fortress of Parisian fashion by the hopelessly unfashionable. Thurston (the "coolest math whiz on the planet," according to an admirer of his YouTube appearance with Fujiwara) modeled an original Miyake blazer created for the occasion at the show and again at the reception. Playing neither the natural man nor the romantic hero ("I can't believe this mathematics guy. He's so... not like what I expected."), Thurston told his interviewer that "Mathematics and design are both expressions of the human creative spirit."³⁷ Like the authors of *Rites*, Thurston referred to truth and beauty in the essay he wrote for the show. "The best mathematics uses the whole mind," he insisted, "embraces human sensibility, and is not at all limited to the small portion of our brains that calculates and manipulates with symbols." But fashion and mathematics haven't yet converged to the point where mathematicians wear logos of rival designers to conferences, and the only other interaction between the two worlds was in the designs, Fujiwara's reaction to the eight 3-dimensional geometries of Thurston's conjecture.

Thurston was back in Paris in June for the ceremony organized by the Clay Mathematics Institute to honor Grigori Perelman for his solution to the Poincaré Conjecture. A grandson of Poincaré was on hand, and the pantheon of the last fifty

years of geometry, with only a few notable exceptions, had been assembled for the occasion, which was extensively covered by the French media (though not more than the *Laboratoire* show). One by one, the distinguished senior geometers stood up to praise the absent Perelman, who had not yet decided to refuse the Clay Institute's million dollars. Only Thurston took the opportunity to express sympathy for Perelman's defense of the romantic ideal against the onslaughts of materialist good intentions:

*Perelman's aversion to public spectacle and to riches is mystifying to many. ... I want to say I have complete empathy and admiration for his inner strength and clarity, to be able to know and hold true to himself. Our true needs are deeper – -yet in our modern society most of us reflexively and relentlessly pursue wealth, consumer goods and admiration. We have learned from Perelman's mathematics. Perhaps we should also pause to reflect on ourselves and learn from Perelman's attitude toward life.*³⁸

Most of the spectators at *Rites*' first screening were artists of some sort, rather than mathematicians, and were apparently drawn from Reine Graves' extensive list of Facebook friends. Once again, it was not hard to identify the mathematicians in the crowd at the post-screening reception, but the contrast was not as jarring as at Thurston's fashion show. On the contrary, the champagne was a democratic vintage and everyone in the *Rites* audience seemed to share a rejection of the *couture* mindset, the artists by design, the mathematicians by indifference. Communication across the cultural divide was cryptic but unstrained. One of Graves' three friends speculated that "Les maths sont là pour exprimer l'essence de la nature" (the math is there to express the essence of nature); another found that "La formule a une beauté calligraphique" (the [tattooed] formula [from Frenkel, Losev, and Nekrasov] has a calligraphic beauty) analogous to the calligraphy at the center of the Noh stage. Number theorist Loïc Merel, on the other hand, thought the film was an exploration of "how to preserve knowledge", but that the question was not taken seriously; the film's language was that of a "conte de fées" [fairy tale].

To mark the conclusion of a year spent in Paris as the occupant of the *Chaire d'Excellence de la Fondation Sciences Mathématiques de Paris*, Frenkel organized a mathematical conference entitled *Symmetry, Duality, and Cinema* at the Institut Henri Poincaré. Four lectures on mathematical topics of interest to Frenkel were followed by another projection of *Rites d'Amour et de Math*. At the champagne reception that followed³⁹ I took notes while Gaël Octavia, the *Fondation*'s public relations specialist, asked Graves why she decided to make a film about mathematics⁴⁰. Without hesitating, Graves, whose motto is *ne jamais avouer* ("never confess"), gave the very best possible answer. Mathematics, she began, is *un des derniers domaines où il y a une vraie passion* [one of the last areas where there is a genuine passion]. Cinema, according to Graves, is dominated by economics; so is contemporary art. Mathematics, like a very few other activities — she mentioned physics and sculpture — is practiced without complacency [*sans autosatisfaction*]; instead there is a true *exigence au travail*. Mathematicians seek to *percer le mystère*. You can see it at once in *l'oeil qui brille* [the eye that gleams].

Let us gaze back a moment into the gleaming mathematical eye that Graves

finds so compelling. Describing a portrait of Abel by the Norwegian painter Johan Gørbitz, Amir Alexander writes

it is the young man's eyes that grab our attention and draw us irresistibly toward them. Dark and intense, they stand out sharply against Abel's fair complexion and amiable pose. They burn with a fire that suggests deep passions of the soul and profound insights of the mind. Their gaze shoots out from the painting's surface... focused not on us but on a distant point on the horizon... the portrait is of a man ... absorbed by his own inner flame and a vision he perceives far beyond... in the early nineteenth century such representations of radical individualism... were part of the standard iconography of high romantic art. (Duel at Dawn, pp. 253-255)

And looking back at us from romanticism's troubled borderlands, the eyes of Pechorin, Lermontov's *Hero of Our Time*, "shone with a kind of phosphorescent gleam...which was not the reflection of a fervid soul or of a playful fancy, but a glitter like to that of smooth steel, blinding but cold."

Alexander's final chapter compares the portraits of Abel and Galois to the self-portraits of early romantic painters A. Abel de Pujol and O. Runge, as well as to contemporary portraits of Keats and Byron — always the same "oeil qui brille". In contrast, enlightenment mathematicians like D'Alembert and Johann Bernoulli resembled 19th century physicists like Helmholtz and Lord Kelvin, "successful men of the world, showing no hint of the morose sentimentality that became a hallmark of the [romantic] mathematical persona." (pp. 260-61).

"In the film that [Frenkel and Graves] envisioned", writes Henric,

the central character ... fights not for honor [in contrast to Mishima's hero, M.H.], but, like his ancestors in science and philosophy, for truth. So here is the question, philosophical, religious, political, moral: should one sacrifice himself and die for the truth?

Yes, said Socrates, Giordano Bruno, Michel Servet..., and all scholars and thinkers who did not compromise with the truth and preferred death to disowning it. No, said the philosopher Kierkegaard.

In his own mind, Galois had no doubt that he belonged to the first group. Stripped and doomed like a gladiator, Frenkel's Mathematician is a martyr following in the footsteps of Galois or Socrates... or of Hypatia of Alexandria, the third mathematician, with Archimedes and Frenkel, whose biography features a prominent nude scene. Along with another entirely gratuitous nude scene, this one, culminating in her martyrdom, is duly included in Alejandro Amenabar's recent film *Agora*, starring Rachel Weisz as the scientist and philosopher of late antiquity. Amenabar's depiction of Hypatia's murder is lighthearted in comparison with Gibbon's version, in which the crowd literally inserts the knife between the victim's spirit and mortal flesh as if to punish the latter for its presumptuous affirmation of its primacy:

On a fatal day, in the holy season of Lent, Hypatia was torn from her chariot, stripped naked, dragged to the church, and inhumanly butchered by the hands of Peter the Reader and a troop of savage and merciless fanatics: her flesh was scraped from her bones with sharp oyster-shells and her quivering limbs were delivered to the flames.
(Gibbon, *Decline and Fall of the Roman Empire*, Chapter XLVII)

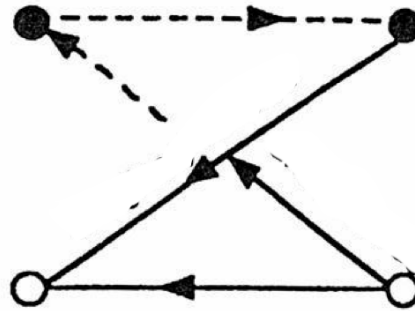
It hardly matters that there is no basis in the scanty historical record for the film's contention that Hypatia died for her defense of scientific rationalism in the face of religious fanaticism⁴¹. On the contrary, as with Alexander's deconstructive reading of the Galois legend, Amenabar's film is less interesting for its history of Hypatia than for what it tells us about our cultural moment: that we need a martyr to truth and beauty, or to the "science et [l']amour" of Leconte de Lisle's 1847 poem *Hypatie*. The following verses could serve as a point by point illustration of Alexander's characterization of the mathematician "absorbed by [her] own inner flame and a vision [she] perceives far beyond":

*Sans effleurer jamais ta robe immaculée,
les souillures du siècle ont respecté tes mains :
tu marchais, l'oeil tourné vers la vie étoilée,
ignorante des maux et des crimes humains.
L'homme en son cours fougueux t'a frappée et maudite,
mais tu tombas plus grande !* (*Hypatie*, Leconte de Lisle)

There is a kind of satisfying symmetry that helps us understand what is peculiar about mathematical madness as it appears in the wider culture. Those mathematicians who turn their eye, gleaming or otherwise, to the "vie étoilée," neglecting the material world, are martyred in the flesh like the Hypatie of Leconte de Lisle's poem, or like Archimedes or Galois, victims of their devotion to their science. Those who assert the primacy of the human mind, like Amenabar's Hypatia, or of the individual mind, like Frenkel's Mathematician, are again martyred in the flesh, victims this time of the "forces of Evil" that seek to extend their control over the material world. Madness, on the other hand, is martyrdom in the spirit, the fate of mathematicians who focus their minds too closely on what must remain unseen, like the protagonists of *Pi* or the Georg Cantor in Amir Aczel's *The Mystery of the Aleph*⁴², or who pursue their intuitions so far into abstraction that they cannot find their way back, like Gweneth Paltrow's father in *Proof* or Cantor (again) in *Logicomix*. With a bit of imagination we can even squeeze these alternatives back into that handy structuralist double binary opposition scheme, as follows:

Lose touch with shared material world
(Galois, Archimedes)

Lose touch with shared mental world
(*Proof*, *Logicomix*)



Oppose material powers
(Amenabar's Hypatia, Frenkel)

Oppose prohibition limiting mental powers
(*Pi*, *Mystery of the Aleph*)

But there is also a persistent asymmetry that brings us back to the scandal with which this essay began, insofar as it is possible to lose one's mind while one's body remains intact, while profane history records no instance of the reverse... except perhaps when the spectator identifies with the martyred characters on screen:

...the spectator is absent from the screen. He cannot identify to himself as object. In this sense, the screen is not a mirror. But this other whom he observes and hears in the film is a psychic prosthesis, an imitation with which it is possible to identify.⁴³

In western metaphysics the specialist in survival of the spirit despite martyrdom in the flesh is Jesus, who famously declared "I am truth." In the Greek of John 14:6, the word for truth is *aletheia*, translated into Russian as *istina*. This is how the word becomes central to Russian Orthodox theology.⁴⁴ Readers familiar with *pravda* as the Russian word for "truth" may have been wondering why Frenkel instead chose the word *istina* for the icon hanging beside Mariko's futon. The answer is that the two terms have different roots, with *pravda* in the semantic complex including the words for law, justice, and rules, while *istina* carries the sense of the adjective *istinnii*, genuine; thus in Lermontov's novel Pechorin's lover could write

...no one can be so truly (istinno) unhappy as you, because no one endeavors so earnestly to convince himself of the contrary.

The *pravednik* is the righteous man one occasionally encounters in the Bible, but we have seen that *istina* is the religious truth Jesus claims to embody; *istina* is also the technical word for mathematical truth, as in Gödel's theorem. Here's Maria Kuruskina's advice, on the AllExperts website, for those of you wondering which word to choose for your next tattoo:

'Istina' is a great deal more pathetic and I'd say lofty or elevated than **'pravda'**. In sentences like "Neo, you're the One because you know the Truth" ... Russians would use 'istina'.

'Pravda' is neutral. It's used in phrases like "you must tell me the truth".

For a tattoo i'd recommend **'istina'** :)⁴⁵

What survives Frenkel's martyrdom is his formula, *istina*, tattooed above his lover's⁴⁶ womb. I will resist the temptation to read this as a promise of the mathematician's spiritual reincarnation and will instead turn to the practical, cinematic, and theological question of how mathematical truth can burst into our lives with the devastating consequences illustrated in *Rites*.

The true (*istinniy*) artist does not want his own truth, whatever the cost, but rather the beautiful, objectively beautiful, that is the artistically incarnated truth (*istina*) of things ...If the truth is there, then the work establishes its own value. (P. Florensky, *Iconostasis*)⁴⁷

I have never consciously attempted to find an equation for love, nor have I knowingly appeared in a movie. But in preparing this essay, I learned that my namesake, the actor Michael Harris, starred as the evil half of a pair of identical twins in the film *Suture*, described as a meditation on mind-body duality and featuring a plastic surgeon named Renée Descartes. And on numerous occasions during the feverish year when I wrote my Ph.D. thesis I woke up vainly trying to recall the formula or the diagram that in my dream had solved one of my many pressing material problems, often with love as primary focus.

Presenting his film at the IHP, Frenkel confirmed Merel's intuition, saying that the film had been conceived as an "allegory" and a "fairy tale." That may be accurate as a description of the film's tone, but not of its narrative arc: a typical (Russian) fairy tale has a 31 part structure, according to Vladimir Propp's classic study *Morphology of the Folktale*, and usually a happy ending to boot. Nor, the *Liebestod* notwithstanding, is *Rites of Love and Math* a tragic romance on the model of *Tristan and Isolde*. In Mishima's *Yūkoku*, Reiko announces to her officer "I know how you feel, and I will follow you wherever you go" and she keeps her word, dying over the beloved warrior's body, as Isolde did before her. No such symmetrical closure concludes *Rites*. Condemned as a sort of human parchment to outlive her fallen lover, Mariko must maintain her mind as a shrine to the lost Mathematician while her body preserves the fatal formula for eternity. Frenkel's second cinematic venture, a screenplay with Thomas Farber entitled "The Two-Body Problem", promises a parade of women in bikinis as a "visual trope,"⁴⁸ but the inconveniently tattooed Mariko will never be among them. Attempts to reconcile the plot with what life has taught me about the material world confronted my mind with unwelcome questions. The Mathematician's mind is safely beyond the reach of the "forces of Evil," but how will Mariko, her skin still stinging from the pain of the tattoo needle, dispose of his body without attracting their attention? Because the Mathematician "wants his formula to live," Mariko has consented to keeping her own body healthy, her skin taut, forever; but how will she explain the formula to her doctor? and what will she tell them at the gym?

Focusing on such questions to fill in gaps in limited information is a precious logical skill in the hands of mathematical crime-fighter David Krumholtz in the TV show *Numb3rs*, or of Elijah Wood and John Hurt in the film *The Oxford Murders*⁴⁹, but is useless in the face of allegory and totally inappropriate on the Noh stage. But if love in *Rites* is to be more than a symbol, a four-letter word illustrated in red and gold

and conventional iconography, the viewer cannot help wondering how the equation is actually supposed to work. Eugene Wigner's canonical version of the mind-body problem concerns "The Unreasonable Effectiveness of Mathematics in the Natural Sciences"; mathematics stands at the mental pole of the antinomy, the universe at that of the body. What troubles me is this: how am I supposed to understand the unreasonable erotic effectiveness of the Frenkel-Losev-Nekrasov love equation?⁵⁰

Setting aside the odd interpretation on the Russian website *Woman Today* —

*It is fully realistic, according to Frenkel, to predict life expectancy precisely, if you have at your disposal the statistics of a person's sexual acts.*⁵¹

— I ask: are the equation's "magic powers" like the magic formulas in Marlowe's *Doctor Faustus*?

*The iterating of these lines brings gold;
The framing of this circle on the ground
Brings whirlwinds, tempests, thunder and lightning;
Pronounce this thrice devoutly to thyself,
And men in armour shall appear to thee,
Ready to execute what thou desir'st.* (Mephistopheles to Faust, Scene V)

Does the love formula bring new love into being or reveal love that is already present but concealed? Can the love formula, like a date-rape drug, force love on the unwilling? Or is that one of the "sinister goals" of the forces of Evil? Is the Frenkel-Losev-Nekrasov equation of Figure 6.8 a record post-facto that explains how your seductions fit into a preordained order, like Pasolini's *Teorema*? Or is it the profane translation of a "Let there be love!" from an alternative Scripture? And does it act on minds, or bodies, or both? Does it act on all bodies, or minds, at once, or on a few at a time? (and in that case how many of each?).

Writing having stalled while I puzzled over these questions, I sent a partial draft to Amir Alexander, who wrote back suggesting I read Frenkel's character, not as one of the archetypes of his own book, but rather as a "classical Renaissance magus" like Dr. Faustus. "A magus is a manipulator of abstract signs, ...not for their own sake (as is the case for the romantics) but rather for earthly power. He may use it for the good, as Frenkel's hero hopes to do, but his power is always suspect..."

Before he became a filmmaker, Ed Frenkel was known as a brilliant product of the incomparable Moscow mathematical school⁵², and indeed was one of the last mathematicians to be trained in that school before it broke up along with the Soviet Union, when many of the best known Russian mathematicians left for Europe, Israel, and (especially) North America. In their important book *Naming Infinity*, Loren Graham and Jean-Michel Kantor trace the rise of Moscow mathematics to the influence of the Russian Orthodox doctrine of *name worshipping* (имяславие), whose theology and religious practice are based on the postulate that "The name of God is God Himself."⁵³ Treated as a heretical sect by the Orthodox hierarchy, persecuted by Soviet authorities, the name worshippers included Dmitri Egorov and Nikolai Luzin, considered by Graham and Kantor to be the founders of the Moscow school, as well as their colleague, the mathematician, engineer, philosopher, Orthodox theologian

(and priest) — and political martyr⁵⁴ — Pavel Florensky.

Just as the name worshippers believed that the repetition of the name of God in the Jesus prayer would bring them into the presence of God, the Moscow mathematicians, according to Graham and Kantor, maintained that mathematical objects were brought into being in the course of giving them names. It seems from this description that name worshipping goes further in breaking through the mind-body barrier than mathematics, whose naming process remains on the mental side. But Moscow mathematician A. N. Parshin, a contemporary interpreter of Florensky, views both word and meaning in purely mental terms.

...the meaning of a word represents itself as a wave of (intelligible) light, located in supersensible space. ... the perception of a word is not merely connected to the perception of light, it *is* the perception of light, but a mental light.

And

...vision arises from the sense of touch. Florensky liked this idea very much. The primary sense, the primary mode of knowledge, is touch of the surface, while vision is touch by means of the retina. ... we may conclude that reflection in the act of knowing takes place by means of reflection with respect to the surface of the body, that is all the surface of the body is a **mirror**.⁵⁵

The name worshippers pronounced the name of God — many more times than thrice — not for earthly power but to bring about a spiritual experience. The Moscow mathematicians went beyond manipulation of their abstract signs by giving them names. The theory behind the "love equation" is analogous: invocation of the formula suffices to bring "eternal love" (as well as youth and happiness).

From this perspective *Rites* is not a fairy tale but rather an allegorical expression of theological mysticism. But everything about the film's imagery suggests that its sphere of action is not limited to the mind but, like the Faust legend, encompasses the realm of the senses in its full materiality, not merely the realm of mental perception to which Parshin alludes. Is this the transgression for which Frenkel's Mathematician must pay with his life? Or are the filmmakers reaffirming the principle the Abbé Suger had inscribed on the doors of the Basilica of St. Denis?

Mens hebes ad verum per materialia surgit
(The dull mind rises to truth through that which is material)⁵⁶

Florensky challenges our dull minds with a series of cryptic definitions of the body. Each definition illuminates a different aspect of the mind-body problem while reinforcing Parshin's conception of the body as mirror: "The body is the most spiritualized substance and the least active spirit, but only as a first approximation." "The body is the realization of the threshold of consciousness." "The body is a film that separates the region of phenomena from that of noumena."⁵⁷ Of particular relevance to *Rites* is the following:

That which is beyond the body, on the other side of the skin, is the

same striving for self-revelation, but hidden to consciousness; that which is on this side of the skin is the immediate presence of the spirit, and thus not extended beyond the body. In being conscious, we clothe ourselves [literally "robe" as in the church], and ceasing to be conscious, we lay ourselves bare.⁵⁸

The passage is obscure but I will risk a possible interpretation. Parshin has written that "reflection with respect to" the mirror that is the surface of the body "exchanges the internal and the external."⁵⁹ Florensky seems to be saying that when we are (figuratively speaking) dressed, the surface of the body acts as in Parshin's model, exchanging the region of noumena — the intelligible (*умопостигаемый*) — with that of phenomena — the sensual (*чувственный*), both of which are located within the mind; this is what it means to be conscious. And when we're undressed — well, while we're unconscious, the body is doing its thing, and who knows what *that's* about?

I mean, who *really* knows?⁶⁰ Who can know well enough to express it all in a formula? Maybe what the existentialists couldn't understand in the monographs they caressed was what their formulas and arcane language had to do with human freedom, responsibility, and desire. Lacan's heckler was right: "*L'homme ne peut pas se résoudre en équation*" (man cannot be expressed in an equation). Nor could that couple in Figure 6.6 really be reduced to canonical form. At least that's what Florensky thought. Writing about love, he explains what he sees as Spinoza's category mistake:

For love is directed toward a person, whereas desire is directed toward a thing. But the rationalistic understanding of life does not distinguish, and is not able to distinguish, between a person and a thing. More precisely, it has only one category, the category of thingness, and therefore all things, including persons, are reified by this understanding, are taken as a thing, as *res*.⁶¹

Two versions of the Frenkel-Losev-Nekrasov love equation from *Rites of Love and Math*

$$\begin{aligned}
 \int_{\mathbb{CP}^1} \omega F(qz, \bar{q}z) &= \sum_{m, \bar{m}=0}^{\infty} \int_{|z| < \epsilon^{-1}} \omega_z z^m \bar{z}^{\bar{m}} dz d\bar{z} \cdot \frac{q^m \bar{q}^{\bar{m}}}{m! \bar{m}!} \partial_z^m \partial_{\bar{z}}^{\bar{m}} F \Big|_{z=0} \\
 (5.7) \quad &+ q\bar{q} \sum_{m, \bar{m}=0}^{\infty} \frac{q^m \bar{q}^{\bar{m}}}{m! \bar{m}!} \partial_w^m \partial_{\bar{w}}^{\bar{m}} \omega_{w\bar{w}} \Big|_{w=0} \cdot \int_{|w| < q^{-1} \epsilon^{-1}} F w^m \bar{w}^{\bar{m}} dw d\bar{w}.
 \end{aligned}$$

Figure 6.8. The love equation, conscious

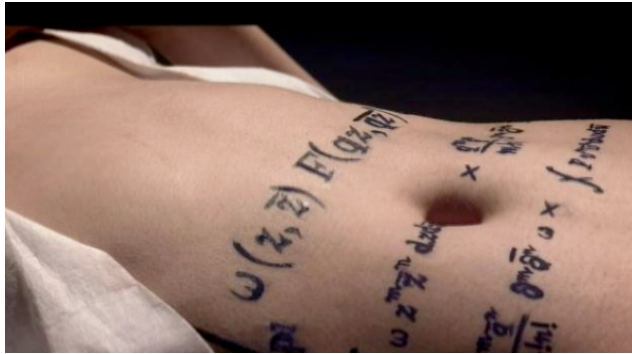


Figure 6.9. The love equation, embodied

You might say — and you would hardly be the first to say it (see Chapter 8) — that love, as a subjective experience, is exactly what cannot be expressed in a formula. That's what makes it subjective rather than a variant of "thingness." The body can be tattooed from head to foot with an owner's manual, rules for operation (*pravila expluatatsii*) sent down from the mental heavens, but neither alone nor in combination will they produce the experience of true love (*istinnaya lyubov'*) that springs out with our bodies from the earth. Frenkel's Mathematician's Ultimate Formula of Love, subordinating the body to the calculating mind, can only work by means of a category mistake. In other words, it can't work. And that's why the Mathematician has to die. Otherwise no one would ever believe it possibly could have worked!

Florensky saw not only love but also the relation to truth (*istina*) as essentially personal:

Christ said: I am Truth. The main point is that the truth is a personality, not a mere object. Florensky formulates this in the framework of pure philosophy. For Florensky, an act of knowledge is a communication or relation, even a kind of "friendship" between the two persons, the one who studies and the one who is studied. (A. N. Parshin, personal communication; my emphasis).

For pure mathematicians in the romantic mold, Parshin's mirror model — physical reality as mediation between sensual experience and the intelligible world, our gleaming eyes turned, like Hypatie's, toward the stars, there to find the "land of truth and beauty" of which Alexander wrote — seems just about right. The mirror is mirrored by the words of Simon McBurney, director of London's *Théâtre de Complicité*, explaining how mathematics works as a metaphor for love when no formula is possible:

*"Infinity is a way to describe the incomprehensible to the human mind," he said. "In a way it notates a mystery. That kind of mystery exists in relationships. A lifetime is not enough to know someone else. It provides a brief glimpse."*⁶²

Goethe reincarnated the magus Faust as a romantic hero, as Mephistopheles was well aware:

*Ihm hat das Schicksal einen Geist gegeben,
Der ungebündigt immer vorwärts dringt,
Und dessen übereiltes Streben
Der Erde Freuden überspringt.*

Fate hath endow'd him with an ardent mind,
Which unrestrain'd still presses on for ever,
And whose precipitate endeavour
Earth's joys o'erleaping, leaveth them behind.

And though Faust eventually died, his Truth survived him, and the angels cheated Mephistopheles of his soul:

*Die sich verdammen,
Heile die Wahrheit;
Daß sie vom Bösen
Froh sich erlösen*

Those that damn themselves,
be healed by Truth;
so that from Evil
They gladly release themselves.⁶³

Sometimes I think the whole mad/martyr/mathematician angle is a ruse to trick the forces of Evil, to cheat the boardroom Mephistopheles who are skeptical that our efforts will bring them tangible returns. Our readiness to sacrifice our minds and bodies to our science is the ultimate proof that what we are doing is important, even if as far as any observer can see we never leave our side of the mirror.

¹ Quotation from Has translated from French subtitles; the translation of Plato is from [Nightingale 2004], p. 115, with slight modifications suggested by Marwan Rashed.

² *The aesthetics and psychology of the cinema*, trans. Christopher King.

³ [Lévi-Strauss 1992] 99-100.

⁴ An apt choice: see [Dreyfus 2010].

⁵ Actually an authentic equation in the theory of vertex algebras, reproduced in Figure 6.8 from the article [Frenkel et al. 2010].

⁶ See <http://videos.tfl.fr/infos/2010/mathematiques-le-genie-russe-refuse-1-million-de-dollars-5787192.html>

⁷ [Spinney 2010], [Mazzucato 2010]

⁸ "It's worth noting that almost all films involving mathematicians depict them as clever, whether they are also crazy, schizophrenic, or ruthless murderers." referring to Robert Connolly's *The Bank*. From M. Emmer, *The Mathematics of Enigma*, in M. Emmer, Mirella Manaresi, eds., *Mathematics, Art, Technology, and Cinema*.

⁹ [Alexander 2011], p. 3.

¹⁰ It's not true, for example, that Galois first wrote up his main discoveries the night before his fatal duel; nor was he ignored and rejected by the mathematical establishment; and there is no reason to believe his duel over Stéphanie was arranged by his political enemies. Alexander was not the first to bring these facts to our attention — see [Rothman 1982] — but to my knowledge he was the first to theorize why the fabrication was and remains so successful.

¹¹ Or Thales who, in his cameo in Plato's *Theaetetus*, falls in a well while studying the stars.

¹² The quotation under the entry for *wrangler* dates from 1751.

¹³ Notice on Clairaut, Diderot and Grimm, 1 juin 1765. In his 1748 novel *Les bijoux indiscrets*, Diderot expressed skepticism regarding the erotic potential of mathematics. The novel concerns a magic ring that endows a woman's *bijou* with the gift of speech, and the secrets revealed in this way. The *bijou* of a woman who had studied geometry was incomprehensible: "Ce n'était que lignes droites, surfaces concaves, quantités données, longueur, largeur, profondeur, solides, forces vives, forces mortes, cône, cylindre, sections coniques, courbes, courbes élastiques, courbe rentrant en elle-même, avec son point conjugué..."

¹⁴ [Clairaut 1745], reprinted and placed in context in [Boudine-Courcelle 1999]. My thanks to Olivier Courcelle and Jean-Pierre Boudine for this reference. See also [Boudine 2000] quoted in [Justens]. Diagram from books.google.com.

¹⁵ Maupertuis was a friend of the Marquis d'Argens, author of the novel *Thérèse philosophe*, which features a chapter entitled *Thérèse se procure machinalement des plaisirs charnels*.

¹⁶ With respect to the 66-day version of the book, no longer considered reliable. The quotations can be found in the authoritative 1804 version, edited by François Rosset and Dominique Triaire. In my edition the flirtation begins on p. 231 and their marriage is announced on p. 607.

¹⁷ [Brown 1997]. The French were hardly the first to appreciate the erotic potential of mathematics. Medieval Hindu exercise manuals included problems like this one from the *Manoranjana*, a commentary on Bhaskara's *Lilavati* written by one Ramakrishna Deva [Brahmagupta-Bhaskara-Colebrook 1817]:

"The third part of a necklace of pearls, broken in an amorous struggle, fell to the ground: its fifth part rested on the couch; the sixth part was saved by the wench; and the tenth part was taken up by her lover: six pearls remained strung. Say, of how many pearls the necklace was composed."

¹⁸ Byron wrote in his diary that "Lady B. would have made an excellent wrangler at Cambridge."

¹⁹ [Zamyatin, 1924] Record Twenty-Seven.

²⁰ Bourbaki's structuralism is treated at length in the next chapter. The catastrophe theory of (the non-Bourbakist) René Thom, like structuralism, is a 20th century revival of Leibniz' *mathesis universalis*, but arising within mathematics itself. At one time or another catastrophe theory, like the structuralist double binary opposition scheme illustrated below, has been applied to everything. For a catastrophe-theoretic approach to sex, see [Hubey 1991]. Hubey's abstract begins "A nonlinear differential equation model and its associated catastrophe is shown to model the simplest version of the sexual response of humans. The mathematical model is derived via well-known and non-controversial aspects of sexual orgasm as can be found in the literature." Hubey's love equation is

$$\ddot{\Psi} + 2\omega_{\pi}\dot{\xi}\dot{\Psi} + \omega_{\pi}^2\Psi + \mu\Psi^3 = A\sin(\Omega t)$$

where " Ψ represents 'sexual tension', Ω is the frequency of the 'excitation', and μ is some non-linearity parameter".

²¹ This passage is from a letter to his sister, the philosopher Simone Weil, written in 1940 upon discovering the "topological" insight mentioned in Chapter 2. The same imagery, culminating in an allusion to the Bhagavad-Gita, reappears in Weil's 1960 article quoted in Chapter 7. Both of Weil's texts derive pleasure from witnessing an intimate coupling between two branches of mathematics; a text by Grothendieck from the 1980s, quoted less frequently, evokes the "deep kinship between the two passions that had dominated my adult life" by casting the mathematician and *la mathématique* as the erotic partners:

It's surely no accident if in French as well as in German, the word that designates [mathematics] is of the female gender, as is "la science" which encompasses it, or the still vaster term "la connaissance" [knowledge] or again "la substance." For the genuine mathematician, by which I mean the one who "makes mathematics" (as he would "make love") there is indeed no ambiguity regarding the distribution of roles in his relation to *la mathématique*, to the unknown substance, then, of which he acquires knowledge, which he knows by penetrating her. Mathematics is then no less "woman" than any woman he has known or merely desired — of whom he has sensed the mysterious power, attracting him into her, with that force at once very sweet, and unanswerable. [Grothendieck 1988], p 496.

Frenkel, at two generations' distance from Grothendieck, would never express himself in this way, but some mathematicians in the US — men as well as women — found the imagery of *Rites*'s trailer

uncomfortably reminiscent of the "distribution of roles" Grothendieck found all too natural, and protested when Berkeley's MSRI announced it was co-sponsoring a special showing of *Rites* in a downtown Berkeley theater. The protestors worried that spectators viewing *Rites* would get the message that the "genuine mathematician" is a man, and convinced the MSRI to withdraw its sponsorship (the showing was nevertheless sold out, even standing room only, with 100 unable to get tickets at all). It's funny to note that the only mainstream film to have represented the mathematician's partner unequivocally as a sex object is the avowedly feminist *Conceiving Ada*, whose "computer genius" protagonist shares her private moments with a husky bearded boyfriend who divides his on-screen time between watching adoringly while she interacts with phantoms behind the computer screen, getting her pregnant, and making coffee. (In *A Beautiful Mind*, shown in Berkeley with MSRI co-sponsorship, John Nash's wife is the archetypal self-sacrificing maternal figure.)

²² <http://aejcpp.free.fr/lacan/1969-12-03.htm>, reproduced from *Magazine Littéraire* Spécial Lacan, number 121 de Février 1977. See also <http://www.psychanalyse-paris.com/Il-eusse-phallus.html> for a discussion of Lacan's analysis of the castration complex in terms of the golden ratio.

²³ Elisabeth Roudinesco, quoted in French wikipedia.

²⁴ 'Alain Badiou: Philosophical Outlaw' in: Gabriel Riera (ed), *Alain Badiou: Philosophy and Its Conditions* (SUNY Press, Albany, 2005), 137–185.

²⁵ Private communication, June 18, 2010.

²⁶ *Rites* was in competition at the June 2010 Sexy International Paris Film Festival (SIPFF), but was not listed among the prize winners. See www.sexyfilmfestparis.fr.

²⁷ She has instead been consecrated, like her contemporary Galois, or her father, as a romantic martyr; cf. the film *Conceiving Ada* mentioned in the first paragraph as well as William Gibson's novel *The Difference Engine* and several books for a general audience.

²⁸ Quotations from Alexander, *op. cit.*, pp. 86–89.

²⁹ [Alexander 2011], p. 13. This may not be unrelated to their poor reputation as lovers: "...it's maybe because of math's absolute, wholly abstract Truth that so many people still view the discipline as dry or passionless and its practitioners as asocial dweebs." [Wallace 2000]

³⁰ *Rites of Love and Math*, opening frames.

³¹ [Alexander 2011], p. 49. After reading this paragraph, Alexander pointed out a third possible archetype, see below.

³² Чем глубже мы погружаемся в материальный мир, тем дальше мы от него отдаляемся в направлении мира идеального. *Light and Word* (Свет и Слово), in [Parshin 2002].

³³ All quotes from [Ikeda-Bonnet 2008].

³⁴ [Menkes 2010]

³⁵ <http://abcnews.go.com/Entertainment/wirestory?id=10017982&page=2>.

³⁶ <http://www.youtube.com/watch?v=YZXLLNbi76o>

³⁷ Comments and quotation at <http://www.youtube.com/watch?v=eQAuSGvQjN0&feature=related>

³⁸ See <http://www.claymath.org/poincare/laudations.html>. Mikhail Gromov, also on hand at the Perelman ceremony in Paris, had been quoted a year earlier to the same effect: Perelman's "main peculiarity is that he acts decently. He follows ideals that are tacitly accepted in science." [Gessen 2009], p. 111. Gessen herself decided while writing her book that Perelman "has an internally consistent view of the world that is entirely different from the view most people consider normal"—her definition of "crazy" (on the book's amazon.com page).

³⁹ No coincidence: there's always a champagne reception.

⁴⁰ Two films, actually, including one still in production in collaboration with my colleague Pierre Schapira.

⁴¹ Much less that she anticipated Kepler's theory of planetary orbits by a good twelve centuries.

⁴² [Aczel 2001]

⁴³ *le spectateur est absent de l'écran. Il ne peut pas s'identifier à lui-même comme objet (p68). En ce sens, l'écran n'est pas un miroir. Mais cet autrui qu'il observe et entend dans le film est une prothèse psychique, un postiche auquel il est possible de s'identifier* [Metz 1977], p 10.

⁴⁴ We will encounter the very different figure of naked truth, Horace's *nuda veritas*, in Chapter 10.

⁴⁵ From <http://en.allexperts.com/q/Russian-Language-2985/truth.htm>. I thank Yuri Tschinkel for this link. A. N. Parshin, on the other hand, points out an old Russian proverb where the emotional content

of the two terms seems to be reversed. The proverb is based on Psalm 85:11, which reads "Truth shall spring out of the earth; and righteousness shall look down from heaven" in the King James version. In the Russian bible, where the verse is numbered 84:12, "Truth" and "righteousness" are translated *istina* and *pravda*, respectively, and so the proverb becomes *Истина от земли, а правда с небес: istina* from the earth, and *pravda* from the heavens. The Hebrew words are *emet* and *tsedek*.

⁴⁶ Among the Chinese characters composing Mariko's name is one meaning "real" or "true".

⁴⁷ ...истинный художник хочет не своего во что бы то ни стало, а прекрасного, объективно-прекрасного, то есть художественно воплощенной истины вещей.... Лишь бы это была истина, — и тогда ценность произведения сама собою установится.

⁴⁸ http://events.berkeley.edu/?event_ID=34214&date=2010-09-15&tab=all_events

⁴⁹ In which a police inspector screams "Did you fucking know about this? You and your fuckin' equations?"

⁵⁰ To forestall possible misunderstandings, I remind readers that the equation in question was published in an article having nothing to do with love or film, several years before Frenkel began his collaboration with Reine Graves. It might also be mentioned that the algorithm for the online dating service OK Cupid, created by four Harvard math majors in 2004, was sold in 2011 for \$50 million, making it by some measure the most successful love formula in history — unless you count Facebook, created at Harvard that same year.

⁵¹ Точно узнать продолжительность жизни, по мысли Френкеля, вполне реально, если иметь в распоряжении статистику половых актов конкретного человека. <http://woman-today.ru/themes/world/9942/>. No one knows where they got this idea.

⁵² As a teenager he may have seen this movie on Soviet TV: <http://www.imdb.com/title/tt0216755/>.

⁵³ A. N. Parshin points out that the name-worshippers' postulate continues "but God is not His name."

⁵⁴ [Graham-Kantor 2009] gives a detailed account of Florensky's martyrdom. Florensky has been repeatedly accused of anti-semitism, especially in connection with the Mendel Beilis blood libel of 1913. [Pyman 2010] examines the evidence for this accusation and finds it inconclusive.

⁵⁵ From *Light and Word* [Parshin 2002] and *Staircase of Reflections*, respectively.

⁵⁶ According to Erwin Panofsky, Suger wrote this verse under the influence of Pseudo-Dionysius the Areopagite, author of *On the Divine Names* and *The Celestial Hierarchy*, among other works. According to Parshin, Pseudo-D. insists in *The Celestial Hierarchy* on the fact that "every angel is a mirror: he accepts light in order to reflect it." (Parshin, *Mirror and Reflection*). I found this translation at <http://www.esoteric.msu.edu/VolumeII/CelestialHierarchy.html>: "[The Hierarchy] moulds and perfects its participants in the holy image of God like bright and spotless mirrors which receive the Ray of the Supreme Deity -which is the Source of Light; and being mystically filled with the Gift of Light, it pours it forth again abundantly, according to the Divine Law, upon those below itself."

⁵⁷ Florensky is quoted by Parshin in his *Staircase of Reflection* in the Russian original: *Тело есть наиболее одухотворенное вещество и наименее деятельный дух, <...>, но лишь в первом приближении; Тело есть осуществленный порог сознания; Тело есть пленка, отделяющее область феноменов от области ноуменов.* The translations are mine. The Russian word *пленка*, which traditionally designates a very thin boundary between two media, is also the contemporary term for the material on which the images of a film are recorded. Note that for Florensky, the body is a film separating two regions of the mind. The Russian text *Лестница отражений (от гносеологии к антропологии)* of *Staircase of Reflection*, is at http://old.bfrz.ru/cgi-bin/load.cgi?p=news/rus_filos/rezume_organizator/parshin/parshin.txt

⁵⁸ То, что за телом, по ту сторону кожи, есть то же самое стремление само-обнаружиться, но сознанию сокрытое; то, что по сю сторону кожи есть непосредственная данность духа, а потому не выдвинутая вне его. Сознывая, мы облачаем, и переставая сознывать - разоблачаем себя самих. (My translation, with Parshin's help.)

⁵⁹ In *Mirror and Double*. The concept of a mirror that exchanges the images on either side is paradoxical. The reader is encouraged to try to draw a diagram, which may or may not resemble that drawn by Florensky in his *Limits of Knowledge*; for Florensky there is an infinite staircase of steps between the two worlds. I thank A. N. Parshin for this reference.

⁶⁰ See *Rig Veda*, 10:129.

⁶¹ Ведь любовь возможна к лицу, а вождение — к вещи; рационалистическое же жизнепонимание решительно не различает, да и не способно различить лицо и вещь, или,

точнее говоря, оно владеет только одною категорией, категорией вечности, и потому все, что ни есть, включая сюда и лицо, овеществляется им и берется как вещь, как res. [Florensky 1997].

⁶² [Zinoman 2010]

⁶³ Faust, Part I, lines 1856-59; translation <http://www.online-literature.com/goethe/faust-part-1/5/>; Part II, lines 11804-807, translation with the help of Yuri Tschinkel)