BOOKS: FICTION

Rhetoric and the Math Melodrama

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Math's cultural stock has risen hard in recent years, no doubt driven by the same booming and metastatic Knowledge Economy that's turned yesterday's non grata nerd into today's cybertycoon. Call the phenomenon "Geek Chic" or "Hip(2b)^2" or whatever you will: abstract tech is now sexy, the mathematician a viable commercial hero—see, for example, the success of recent films like *Good Will Hunting* and π.

The Wild Numbers
by Philibert Schogt
Four Walls Eight Windows, New York, 2000. 159 pp. $18. ISBN 1-56858-166-1.

Or, a better instance of math's new cachet here is Amir D. Aczel's *Fermat's Last Theorem: Unlocking the Secret of an Ancient Mathematical Problem*, which made nonfiction bestseller lists in 1996 and transformed Princeton's Andrew Wiles into a weird kind of horn-rimmed pop icon, and in the wake of which has appeared everything from Paul Hoffman's *The Man Who Loved Only Numbers* and Sylvia Nasar's *A Beautiful Mind* to David Berlinski's *Newton's Gift* and Charles Seife's *Zero: The Biography of a Dangerous Idea*.

Uncle Petros & Goldbach's Conjecture
by Apostolos Doxiadis
Bloomsbury USA, New York, 2000. 219 pp. $23.95. ISBN 1-58234-067-6.

Though fiction, Philibert Schogt's *The Wild Numbers* (herein *WN*) and Apostolos Doxiadis's *Uncle Petros & Goldbach's Conjecture* (herein *UPGC*) both draw heavily on Aczel's *Fermat's Last Theorem* as well as on G. H. Hardy's *A Mathematician's Apology* (*1*). And there are other, rather striking similarities between the two novels. Both are set in the world of academic mathematics and feature characters whose specialty is number theory, higher math's most purely abstract branch. Both revolve around their protagonists' quests to solve famous and long-standing number-theoretic problems. And both have been translated by their own authors from foreign-language originals.

The facts of these two novels' close resemblance and near-simultaneous release here in the United States, as well as the vigor with which their U.S. publishers are hyping them (*2*), appear to signal the inception of a whole new commercial genre—the "Math Melodrama," as it were. This is a development that should come as no surprise, given the success of some of the other titles mentioned above, not to mention the commercial success in recent years of other nascent tech-intensive genres (e.g., the cyberpunk of Gibson *et seq.*, the Clancy-style technothriller, and the plucky-young-hackers-thwarting-evil-monolithic-institutions of *Sneakers*, *Hackers*, and *The Matrix*).

As exemplified by *WN* and *UPGC* in fiction and *Fermat's Last Theorem* and *A Beautiful Mind* in non-, the Math Melodrama can be roughly characterized as combining the "Vocational Travelogue" (*3*) charms of genre authors like Arthur Hailey and Michael Crichton with some of the weightier allegorical functions that other genres and their heroes often serve—the Western sheriff as emblem of Apollonian order, the Noir private eye as existential hero, the plucky young hacker as Odyssean trickster. The Math Melodrama's own allegorical template appears to be more classically Tragic, its hero a kind of Prometheus-Icarus figure whose high-altitude genius is also hubris and Fatal Flaw. If this sounds a bit grandiose, well, it is; but it's also a fair description of the way Math Melodramas characterize the project of pure math—as nothing less than the mortal quest for Divine Truth. What's odd here is that whether a particular reader accepts this characterization or sees it as pretentious and silly will often depend less on the qualities of the Math Melodramas themselves than on certain biographical facts about the reader, namely how much knowledge and experience of higher math he or she happens to have.

This sort of oddity is, in fact, a frequent problem in reviewing "genre fiction," which is a type of narrative it's usually fair to call "the sort of thing someone who likes this sort of thing is apt to like." The evaluative criteria tend to be rather special for such fiction. Instead of the basically aesthetic assay the reviewer gets to make of most literary fiction—"Is this piece of fiction good?"—criticism of genre fiction is ultimately more rhetorical—"To whom will this piece of fiction appeal?" In other words, as is the case with all but the broadest and coarsest genre fiction, the central questions about novels like *WN* and *UPGC* concern what rhetoricians call "audience": What is the intended audience for these books? and is this audience apt to find the novels satisfying on the same terms by which it finds other Math Melodramas satisfying? and if not, are there other audiences whom these books are more likely to satisfy? and so on. One reason this is a problem for reviewers is that book reviews are usually supposed to be short, clear, and relatively simple; but rhetorical criteria tend to yield very complex, sometimes even paradoxical conclusions. In the case of *WN* and *UPGC*, the paradox is that the type of audience most likely to accept and appreciate these novels' lofty, encomiastic view of pure math is also the audience most apt to be disappointed by the variously vague, reductive, or inconsistent ways the novels handle the actual mathematics they're concerned with.

To put it in a simpler, more book review-ish way: Neither of these novels is very good (one, in fact, is downright bad); but the precise ways in which they're not very good will vary directly with how much an individual reader already knows about the extraordinary field these two books are trying to dramatize (*4*).

Not just professional mathematicians, but almost anyone lucky enough ever to have studied higher math understands what a pity it is that most students never pursue the subject past its introductory levels and therefore know only the dry and brutal problem-solving of Calc I or Intro Stats (which is roughly analogous to halting one's study of poetry at the level of grammar and syntax). Modern math is like a pyramid, and the broad fundament is often not fun. It is at the higher and apical levels of geometry, topology, analysis, number theory, and mathematical logic that the fun and profundity start, when the calculators and context-less formulae fall away and all that's left are pencil and paper and what gets called "genius," viz. the particular blend of reason and ecstatic creativity that characterizes what is best about the human mind. Those who've been privileged (or forced) to study it understand that the practice of higher mathematics is, in fact, an "art" (*5*) and that it depends no less than other arts on inspiration, courage, toil, etc., but with the added stricture that the "truths" the art of math tries to express are deductive, necessary, a priori truths, capable of both derivation and demonstration by logical proof (*6*).

It may be that mathematics is not generally recognized as one of the arts precisely because so much pyramidal training and practice is required in order to appreciate its aesthetics; math is perhaps the ultimate in acquired tastes (*7*). And it's maybe because of math's absolute, wholly abstract Truth that so many people still view the discipline

The author's recent works include *Brief Interviews with Hideous Men* and the eBook *Up, Simba!: 7 Days on the Trail of an Anticandidate.*

as dry or passionless and its practitioners as asocial dweebs. Some *Science* readers will probably know all too well the frustration of trying to describe the beauty and power of Gauss's differential geometry or the Banach-Tarski Paradox to someone who remembers only the drudgery of factoring quadratic equations or the terror of a trig midterm. In fact, the weird fear and distaste that low-level math provokes in so many is part of what makes the emergence of the Math Melodrama exciting: If the genre can find ways to vivify pure math and communicate the discipline's extraordinary beauty and passion to the average reader (*8*), both readers and math itself stand to gain.

The ways in which Schogt's and Doxiadis's novels go about trying to humanize and animate math are also similar. Besides both struggling to solve classic problems in number theory—the actual Goldbach Conjecture in *UPGC*, a fictitious conundrum called "Beauregard's Wild Number Problem" (*9*) in *WN*—the books' protagonists also both conceive of their projects almost wholly in terms of personal achievement, glory. *WN*'s Isaac Swift, a once-promising student whose career has stagnated, spends much time fantasizing about solving the Wild Number Problem and having "an international symposium held in my honor…and, now that I was not just a mathematician, but a famous mathematician, women would suddenly find me attractive, not just eccentric or at best amusing." And *UPGC*'s Petros Papachristos, although already a number-theorist of substantial reputation who holds an endowed chair at the University of Munich, nevertheless "sought in mathematics a great, almost transcendent success, a total triumph that would bring him world fame.…And to be complete, this triumph should be exclusively his own." Despite their different stations and attainments, the two protagonists also suffer almost identically (and at great length) from the insecurity of measuring themselves against their colleagues and the fear that someone else will solve "their" problem first. Petros actually rejoices when Srinivasa Ramanujan (*10*) dies young of tuberculosis, simply because Ramanujan's "unique intellect was the only force he considered capable of purloining his prize." Both protagonists' work is characterized as an anxious race against the clock and calendar; both novels make much of the fact that pure math is a "young man's game" and that the vast majority of important mathematicians do their best work before 35 (*11*). And both heroes brood and expound at great length about the particular despair of being a good but not immortally great mathematician, a mathematician brilliant enough truly to appreciate the genius of Riemann, Euler, Poincaré *et al.* but not brilliant enough to be their equal.

Interestingly, though, the most important similarity between the novels concerns the rhetorical problems of audience mentioned above, and the biggest differences between the two books concern the ways they try to handle those problems. Oddly, the better novel is also the one that seems to be the more confused and confusing about just what its audience is.

The Wild Numbers, translated from the Dutch *De wilde getallen* and transferred in locale from Amsterdam to some nameless U.S. college town, is not the better novel. It's designed to be sort of a schlemiel-comedy à la Thurber's Mitty or Amis's *Lucky Jim*. *WN*'s Isaac is a mediocrity who at the start of the novel is under-published and reduced to doing scutwork calculations and "refinements" for his superstar colleague Dimitri Arkanov (*12*) and at age 35 goes around saying stuff like "I felt old and depressed. There seemed to be no more room for dreams at my age. Everything was measured in terms of success and failure.…I concluded that I was a lesser human being in every respect." His prospects suddenly change when Isaac stumbles into working on "wild numbers," which are described this way:

> Beauregard had defined a number of deceptively simple operations, which, when applied to a whole number [integer?], at first resulted in fractions [rationals?]. But if the same steps were repeated often enough, the eventual outcome was once again a whole number [huh?]. Or, as Beauregard cheerfully observed: "In all numbers lurks a wild number, guaranteed to emerge when you provoke them long enough." 0 yielded the wild number 11, 1 brought forth 67, 2 itself, 3 suddenly manifested itself as 4769, 4, surprisingly, brought for 67 again.

In an all-nighter of migrainous epiphany, Isaac comes to believe he's found the long-sought answer to the Wild Number Problem, which is apparently a fictional variant of number-theoretic puzzles like the Twin Primes Problem (*13*): "How many wild numbers are there? Are there a finite number that keep coming up, and if so, how many, or are there an infinite number?" Isaac's proof that the set of all wilds is infinite appears at first to be sound, and it is confirmed and lauded by Arkanov and submitted to a prestigious journal, catapulting Isaac into the mathematical limelight and prompting all sorts of wacky plot-complications before it is finally discovered that the proof doesn't work after all (but by which time Isaac's found true love with a caustic divorcée who's also had horrible career reverses, so everything works out O.K. in the end).

The major problem with *The Wild Numbers* looks at first to be artistic but is actually rhetorical. All the book's math is, as mentioned, made up, which is not necessarily a problem—all sorts of great science fiction, from Isaac Asimov to Larry Niven, is replete with fictional math and high tech. What is a problem, though, is that the fictional math in *WN* is extremely important but also extremely vague, comprising mostly repeated and contextless verbiage—"If I could only establish its K-reducibility with the aid of a suitable calibrator set!"—without any definitions or even cursory fleshing-out, so that the book's math-speak ends up most resembling the absurd pseudo-jargon of bad, old low-budget sci fi movies ("Quick, Lieutenant, prepare the antigenic nanomodule for immediate stabilization flux!").

Apart from its intrinsic weaknesses, the sketchy made-up math here clearly indicates that *The Wild Numbers* is meant to appeal mostly to readers with little or no high-math background, an audience that either won't know that the impressive-sounding terminology is fake or won't mind that the terms never get connected to each other or anything else. This, too, is not necessarily a problem; many successful books, from Heinlein's *Stranger in a Strange Land* to Ellroy's *L. A. Confidential*, use sort of perfunctory genre-conventions as scaffolding for what are really complex and essentially human dramas (i.e., for literature). But it's true that a genre book whose particular genre-elements lack technical depth or resonance must depend for its appeal on other, more traditionally literary qualities like plot, character, style, etc. And this is a very real problem for *WN*, because as any kind of literary narrative it is off-the-charts bad, its characters mere 2D types (the neurotic schlemiel, the kindly mentor, the pompous crank, the vulpine reporter, the fiancée who Doesn't Understand) and its plot howlingly implausible (e.g., for most of the book both Isaac and Nobel-laureate Arkanov supposedly fail to spot in Isaac's proof a basic, freshman-level logical flaw, the eventual discovery of which is sort of the novel's pie-in-the-schlemiel's-face climax). Worst, or at least most distracting, is the fact that the author-translator's English seems rudimentary at best (*14*) and the actual line-by-line prose of *WN* is often so stiff and clunky—"How the tiny, quivering flame of my intuition was able to withstand the numerous onslaughts of my doubts remains a mystery to me"—or riddled with ESL-ish solecisms—"She pouted her lip"; "I found back my love for mathematics" (*15*)—or unintentionally funny—"Her tongue probing deep into my mouth left little room for mathematical reflection"—or just plain

bad—"They could not help but open like flowers in the brilliant sunshine of his presence, revealing their innermost secrets to him"—as to make the reader suffer that terrible, embarrassed-for-someone-else feeling on the author's behalf.

It is true that *Uncle Petros & Goldbach's Conjecture* is also author-translated (from the original *O Theios Petros kai i Eikasia tou Golbach*) and its prose often awkward or stilted: "I was not made of the same mettle as he—this I realized now beyond the shadow of a doubt." But here the clunky English is mitigated somewhat by *UPGC*'s Greco-European setting and the fact that much of its action takes place before 1930. The novel's nested structure is itself almost Victorian: The middle-aged narrator, describing in retrospect the history of his childhood relationship with his reclusive uncle, recounts Petros's own life story in a series of flashbacks "as told to" him by the great mathematician himself. The elaborate set-up notwithstanding, it is Petros's obsessive and tormented career that drives the novel and comprises its heart.

UPGC is about as far from a schlemiel-comedy as you can get. It's more like a cross between the Myth of Icarus and Goethe's Werther, and it's serious as a heart attack (*16*). Born in Greece around the turn of the century, Petros Papachristos is recognized as a child math prodigy and shipped across Europe to the University of Berlin, where in 1916 he receives his doctorate with a dissertation on "solving a particular variety of differential equations" that earns young Petros early acclaim because of its applications in WWI artillery targeting. It is also at the university that Petros has his first and only love affair, with his German-language tutor (a young lady by the rather unsubtle name of Isolde), who toys with his affections and then elopes with a Prussian officer. In not its best moment, *UPGC* tries to establish this (wince) Isolde as Petros's initial motive for tackling the Goldbach Conjecture:

> In order to win her heart back, Petros now decided, there could be no half-measures....he should have to accomplish amazing intellectual feats, nothing short of becoming a Great Mathematician. But how does one become a Great Mathematician? Simple: by solving a Great Mathematical Problem! "Which is the most difficult problem in mathematics, Professor?" he asked [his advisor] at their next meeting, trying to feign mere academic curiosity.

Whereupon Petros devotes the remainder of his professional life to the G.C., that Everest of unsolved problems. His twenty-year labor, which ends in failure and devastation, combines periods of seclusion in Germany with extended trips to Cambridge and Vienna, in which latter there are scenes of him rubbing elbows with some of 20th-century math's most important historical figures. The use of this *Forrest Gump*-ish device implies that *UPGC* is written for readers who are at least familiar enough with higher math to know who Hardy, Ramanujan, Gödel, and Turing are; but many of the celebrity-scenes themselves are cheesy and kind of irritating. The complex and sensitive Hardy readers know from his *Apology*, for instance, gets reduced in Doxiadis's novel to a sort of gouty old curmudgeon who spouts inanities like "Don't you forget it, Papachristos, this blasted Conjecture is difficult!"

Goldbach's Conjecture: every even number greater than 2 is the sum of two primes.

Its treatment of the "real" Hardy is a good example of *UPGC*'s particular rhetorical problem: The readers who will actually know who Godfrey Harold Hardy is are also the readers most likely to be put off by the way the book portrays him (*17*). And Doxiadis's novel runs into this sort of logico-rhetorical problem again and again, because its big weakness as genre fiction is its weird, ambivalent confusion about just what kind of audience it's for.

As with Schogt's *WN*, there's no better instance of this confusion than the way pure math is rendered here, although in *UPGC* the math is 100% real and intricately connected to the book's characters and themes. Petros's Herculean labors on his proof are recounted to the reader in the form of fireside declamations to his nephew (i.e., the narrator as a child), who's enough of a mathematical ephebe that Petros can plausibly keep stopping to deliver quick little mini-lectures on the history of number theory, from Euclid's reductio proof of the infinity of primes, to the major theorems of Fermat, Euler, and Gauss on primes' distribution and succession, to the Goldbach Conjecture and Petros's own analytic attack thereon via "the Theory of Partitions (the different ways of writing an integer as a sum)."

It gets more complicated, though, because the narrator as a grown man now has an extensive math background, and he himself laces the novel with explanatory asides on everything from Cavafy poems to the Riemann Zeta Function. The problem is that Doxiadis's decisions about what needs explicating and what doesn't are often so inconsistent as to seem bizarre. It's not just that there are long and irrelevant footnotes on, for example, Gödel's method of suicide, Poincaré's theory of the unconscious, or the novel properties of the number 1729 (*18*). It is that the narrator of *UPGC* will often take time to carefully define very basic terms like "integers" and "primes" or to include patronizing asides like "It should be pointed out to the non-specialist that mathematical [text]books cannot normally be enjoyed like novels, in bed, in the bathtub, sprawled in an easy chair, or perched on the commode"—all of which clearly imply a non-math audience—while, on the other hand, *UPGC* is also studded with rarefied technical phrases like "n's ratio to the natural logarithm," "Peano-Dedekind axiomatic system," "partial differential equation in the Clairaut form," and (no kidding) "The orders of the torsion subgroups of Ω_n and the Adams spectral sequence" that are tossed around without any kind of explanation, which (especially together with the à clef appearances of Gödel, J. E. Littlewood, *et al.*) seems to presume a highly math-literate reader.

And if all the narrator's strange elementary definitions are disregarded as mere slips or snafus, and one decides that *UPGC*'s actual intended audience is one with a solid high-math background (*19*), there remains an equally strange inconsistency. This lies in the narrative's discussions of the Goldbach Conjecture itself, and of its history in the early 20th century. For one thing, *UPGC* makes hardly mention at all of the crucial distinction between Euler's "strong Goldbach Conjecture" [see (*4*)] and the Conjecture's equally famous "weak" version, which states that all odd numbers ≥ 9 are the sum of three odd primes. Nor, despite all the detailed descriptions of Petros's labors and all the long excursuses on pre-WWII number theory, does the novel ever once mention Euler's phi (or "totient") function or the ingenious "sieve"-type methods that real mathematicians were using to attack the G.C. in the 1920s and 1930s. In fact, even though *UPGC* gives us page after page on Petros's anxiety about Ramanujan's work on the G.C. (which was in reality very slight), there's no mention of any of the actual im-

portant published results of the time, e.g. Schnirelmann's 1931 proof of the upper limit of primes of which an even integer can be the sum and Estermann's 1938 proof that almost all even numbers are the sums of two primes. Strangest of all, though Doxiadis's narrator spends a lot of time discussing the difference between algebraic and analytic number theory (as well as tracing out Gauss's "asymptotic" hypothesis of the Prime Number Theorem, and Hadamard and Vallée Poussin's 1896 proof of the P.N.T. using analytic tools), there is not one reference in the book to I. M. Vinogradov, the Russian mathematician who in 1937 revolutionized analytic number theory by introducing a powerful method for getting very accurate estimates of trigonometric sums and using it to prove the weak G.C. for sufficiently large numbers (*20*). Historically, it is Vinogradov who would have been Petros's real rival, the "unique intellect" he really feared; and it is not Gödel's but Vinogradov's Theorem that might plausibly have caused Papachristos to despair.

The thing to realize here is that none of these omissions would necessarily matter had not Doxiadis chosen to make *UPGC* so dependent on actual number-theory and real historical characters. As it stands, though, the audience knowledgeable enough to appreciate all the "real" math and history woven into this novel is also the audience most likely to notice the strange absence in the book of so much really real historical work on the Conjecture. Here once again, then, is a form of the weird, paradoxical-looking problem (viz., that necessary conditions for liking the novel are also sufficient conditions for disliking it) that pretty much destroys this book, whose author can't decide whom he's writing for.

It would be unfair to Doxiadis, though, not to acknowledge that both his novel and its flaws are far more interesting than Schogt's *WN*, and moreover that *UPGC* does include some moving and rather lovely passages:

> The loneliness of the researcher doing original mathematics is unlike any other. In a very real sense of the word, he lives in a universe that is totally inaccessible, both to the greater public and to his own immediate environment. Even those closest to him cannot partake of his joys and his sorrows in any significant way, since it is all but impossible for them to understand their content.

The novel also offers at least one subtheme of genuine insight and originality, one that manages to go beyond anything Hardy had to say about the tragedies of math. This particular thematic line concerns Petros's ambition and his place in the mathematical community; and its allegorical touchstone appears to be not Icarus but Minos, the Cretan king who so coveted a certain great white bull, which the god Poseidon had conjured out of sea-foam to help him win the throne, that Minos broke his sworn promise to return it via religious sacrifice and instead kept the bull for himself (*21*).

It is true that doing original math is "lonely." But it is also true that professional mathematicians compose a community. The reality, which Petros never seems to recognize, is that the "fame and immortality" he so craves will depend entirely on the value of his work to other mathematicians. The role of professional community is so important in nearly all branches of scientific endeavor, in fact, that most *Science* readers can probably already appreciate what Lewis Hyde's *The Gift* (*22*) tries to convey to its own more general audience:

> [T]he task of assembling a mass of disparate facts into a coherent whole clearly lies beyond the powers of a single mind or even a single generation. All such broad intellectual undertakings call for a community of scholars, one in which each individual thinker can be awash in the ideas of his comrades so that a sort of "group mind" develops, one that is capable of cognitive tasks beyond the power of any single person.

Notwithstanding all the narrator's heavy declarations that "Uncle Petros' sin was Pride" and his retreat into paralyzed seclusion "a form of burnout" or "scientific battle fatigue," it emerges in the novel that the real cause of Petros's tragedy is his progressive withdrawal from the professional community as his ambition to solve the Conjecture becomes a rapacity that transforms his colleagues first into rivals and then into enemies. The novel's middle sections trace this progression out nicely. It starts in Cambridge, when Petros rejects an offer of professional collaboration with Hardy and Littlewood because he fears that "[t]heir problems would become his own and, what's worse, their fame would inevitably outshine his," and determines instead to work on the G.C. alone, withdrawing to Munich. There, over years of seclusion and nonstop work, privacy becomes secrecy, and Petros's fear and suspicion of other mathematicians approaches "the point of paranoia. In order to avoid his colleagues' drawing conclusions from the items he withdrew from the library, he began to…ask for an article in a scientific journal only in order to get his hands on the issue that also contained another article, the one he really wanted." (See also Petros's aforementioned "wild joy" at the death of Ramanujan.)

The real Minoan-type crisis, though, comes about halfway through the novel, when Petros achieves an important "intermediate result" in his progress toward the Conjecture—a "deep, pioneering theorem…which opened new vistas in the Theory of Numbers"—and has to decide what to do with it. Petros's internal debate about whether to publish the result (which is really a Hyde-versus-Minos argument about membership in a community) is probably the novel's best moment:

> Undoubtedly, its publication would secure him recognition in the mathematical world much greater than that achieved by his method for solving differential equations. In fact, it would probably catapult him to the first ranks of the small but select international community of number theorists, practically on the same level as its great stars.
>
> By making his discovery public, he would also be opening the way into the [Goldbach] problem to other mathematicians who would build on it by discovering new results and expand the limits of the field in a way a lone researcher, however brilliant, could scarcely hope. The results they would achieve would, in turn, aid him in his pursuit of the proof to the Conjecture. In other words…he would be acquiring a legion of assistants in his work. Unfortunately, there was another side to this coin: one of the new unpaid (also unasked for) assistants might conceivably stumble upon a better way to apply his theorem and manage, God forbid, to prove Goldbach's Conjecture before him.
>
> He didn't have to deliberate long. The danger far outweighed the benefit. He wouldn't publish.

From here on, the die is cast. And because he is not a king, it is not his community but Petros himself who receives the inevitable punishment for this "hoarding of the general benefit" (*23*). What happens is that his unpublished result is independently discovered by another mathematician, a development Petros finds out about only years later, from Hardy, who "expressed his amazement that Petros had not been aware of this, since its publication had caused a sensation in the circles of number theorists and brought great acclaim to its young author" (*24*).

As *UPGC*'s plot unfolds, this sort of Aesopian, reap-just-what-you-sow punishment gets inflicted on Petros again and again, worsening as each ego-blow increases his alienation and paranoia and sends him deeper into a kind of profes-

sional solipsism. Far more than any supposed misreading of Gödel's First Incompleteness Theorem, it is this solipsism that leads to Petros's "failure"—as both a mathematician and a person—and he ends up rather like Milton's Satan, not just alone but Alone, sustaining himself on the sort of megalomaniacal self-pity that creative people everywhere know and dread:

> "I, Petros Papachristos, never having published anything of value, will go down in mathematical history—or rather will not go down in it—as having achieved nothing. This suits me fine, you know. I have no regrets. Mediocrity would never have satisfied me. To an ersatz, footnote kind of immortality, I prefer…total obscurity!"

Despite the confused and confusing math-labyrinth it's hidden inside, the embedded story of Petros's fall is in fact a kind of monstrous gem, one in whose facets readers of many different backgrounds and tastes might see parts of themselves reflected. Apparent implication: If math can be art, so sometimes can genre.

References and Notes

1. This classic long essay, originally published in 1940 and re-released by Cambridge University Press in 1992, is the unacknowledged father of most of the last decade's math-prose. There is very little that any of the recent books do that Hardy's terse and beautiful *Apology* did not do first, better, and with rather less fuss.
2. *WN*'s cover comes with a blurb from *Fermat's Last Theorem*'s Aczel, who must have been on some kind of euphoriant medication—"I have never read a better fictional description of what it's like to work in pure math"—as well as the breathless marketing tag "THE LINE BETWEEN GENIUS AND MADNESS IS A THIN ONE." *UPGC*'s publisher's big tactic is to offer a million-dollar bounty to anyone who can prove Goldbach's Conjecture before 2002.
3. "Vocational Travelogue" is a shorthand way of acknowledging that for a long time one reason people used to read fiction was for a kind of imaginative tourism to places and cultures they'd never get to really see; that modernity's jetliners, TV, etc. have pretty well made this function obsolete; but that modern tech has also created such extreme vocational specialization that today few people are in a position to know much about any professional field other than their own; and thus that a certain amount of fiction's "touristic" function now consists in giving readers dramatized access to the nuts and bolts of different professional disciplines and specialties.
4. In fairness to all concerned, this variability in readers' mathematical backgrounds is a problem for almost anyone trying to write general-interest prose about math, a problem that Hardy refers to as "the restrictions under which I am writing. On the one hand my examples must be very simple, and intelligible to a reader who has no specialized mathematical knowledge....And on the other hand my examples should be drawn from 'pukka' mathematics, the mathematics of the working professional mathematician." Note that this sort of thing is a problem even for rather more special-interest writing like this book review itself. Is it, for example, necessary to inform or remind the average *Science* reader that Fermat's Last Theorem (c. 1637) states that where n is an integer and $n > 2$, the equation $x^n + y^n = z^n$ has no nonzero integer solutions? or that Goldbach's Conjecture (or rather the "strong" G.C. as reformulated by Leonhard Euler in 1742) is that every even integer > 4 can be expressed as the sum of two prime numbers? As it happens, this reviewer is not certain whether it's necessary or not, and the fact that these lines have not been deleted by *Science*'s editors (i.e., that you are reading them at all) may indicate that the editors are not totally sure either.
5. Hardy, whose *Apology* talks about this better than anything else ever has, explains that "The mathematician's patterns, like the painter's or poet's, must be beautiful; the ideas, like the colours or the words, must fit together in a harmonious way. Beauty is the first test; there is no permanent place in the world for ugly mathematics."
6. The assumption here will be that the typical *Science* reader already knows what "a priori," "deductive truth," and "logical proof" mean and is at least roughly familiar with the relationship between pure math and formal logic, if for no other reason than that to gloss tangential stuff like this would take up enormous amounts of space and time and might well also alienate the (presumably large) percentage of *Science*'s readership who already know the stuff and are apt to find such glosses not only otiose but annoying—this reviewer can actually imagine such readers looking increasingly aggrieved and impatient and saying to themselves, "Who does he think he's talking to?" All this is mentioned only to underscore once again the rhetorical diceyness of the whole math-prose enterprise, a diceyness that lies at the very center of this review's criticisms of the two novels.
7. It's worth noting that as so much contemporary poetry, classical music, etc. become ever more abstract and involute and technically complex, their own audiences get ever smaller and more specialized. With few exceptions, the people who truly appreciate a piece of language-poetry or an atonal fugue are people with extensive educations in the history and theory of these arts. And this increasing exclusivity in the arts has much less to do with good old "cultural elitism" than with our era's tendency toward greater and greater specialization—it is not at all an accident that the majority of people who read contemporary poetry are themselves contemporary poets.
8. "Average reader" is kind of a synecdoche for "people who read mainly for diversion or entertainment." These people are American genre fiction's basic audience. It is true that Hardy's *Apology*, as well as novels from Don DeLillo's *Ratner's Star* and Thomas Pynchon's *Gravity's Rainbow* to Neal Stephenson's *Cryptonomicon* have already deployed higher math in interesting and significant ways. But books like these are belle lettres, literature, for which the audience is, again, usually small and rather specialized. Genre books are mass-audience books and are marketed accordingly.
9. The putative author of this problem, one "Anatole Millechamps de Beauregard" (b. 1791), is a kind of biographical hybrid of von Neumann and Galois, on whose florid life story Schogt spends most of a chapter.
10. Like many of *UPGC*'s supporting characters, Ramanujan was a real number-theorist, an Indian savant discovered and mentored by Hardy. Robert Kanigal's *The Man Who Knew Infinity: A Life of the Genius Ramanujan* is another of the post-Fermat math-bios now on the market.
11. The real source of this insight is Hardy, in his *Apology*'s famous "No mathematician should ever allow himself to forget that mathematics, more than any other art or science, is a young man's game," which *UPGC*'s narrator rips off without any attribution at all: "Mathematics, you see, is a young man's game. It is one of the few human endeavors where youth is a necessary requirement [sic] for greatness." This is probably the place to point out that Doxiadis's whole novel is filled with what appear to be little more than very slight rephrasings from Hardy's *Apology* or C. P. Snow's famous Foreword to it. At one point, Doxiadis even cribs nearly word for word a deathbed exchange between Hardy and Ramanujan and tags it with the footnote "Hardy also recounts the incident in his *Mathematician's Apology* without, however, acknowledging my uncle's presence." This is not only intrusive and irritating but wrong, because it is not in the *Apology* but in Snow's Foreword that the scene really appears.
12. The work Isaac is doing for Arkanov is on "calibrator sets" and "K-reducibility," two made-up terms that figure prominently in the plot's math but are never specified or explained.
13. Here the reviewer's assumption is that if the T.P.P. is unfamiliar or the analogy unhelpful it can just be passed over with no hard feelings on either side.
14. Schogt's original Dutch prose might, of course, be a thing of wonder.
15. *The Wild Numbers*' American publisher seems equally culpable for the prose here. If Four Walls Eight Windows is going to let an only semi-bilingual Philibert Schogt translate his own Dutch, why didn't they at least help him with basic English usage.
16. And it's just about as subtle with respect to its thematics: The narrator repeatedly and sans irony describes his uncle as an "Ideal Romantic Hero" (caps his) and says stuff like "Think of the biblical Tree of Knowledge or the Prometheus of mythology. People like him have surpassed the common measure; they've come to know more than is necessary to man, and for this hubris they have to pay."
17. There's a way more grievous example of this sort of thing involving Kurt Gödel and the plot's first real crisis. Alan Turing (here a wide-eyed undergrad) accidentally exposes Petros to Gödel's First Incompleteness Theorem in 1933, whereupon Petros freaks out because he fears that the Goldbach Conjecture may be one of the F. L. Theorem's "formally unprovable" propositions. This is so implausible and reductive as to be almost offensive. As *Science*'s readership is hereby presumed [q.v. (*6*)] to more or less know already, Gödel's First Incompleteness Theorem is concerned with the abstract possibility of Completeness in axiomatic systems, and the formally unprovable propositions it succeeds in deriving are all very special self-reference-type cases, the mathematical equivalent of the "I am lying" paradox. To believe that the First Incompleteness Theorem could apply to actual number-theoretic problems like the Goldbach Conjecture is so crude and confused that there is no way that a professional mathematician of Petros's attainments could possibly entertain what the novel says is "the one and only, dizzying, terrifying question that had jumped into his mind the moment he'd heard of Gödel's result.... what if the Incompleteness Theorem also applied to his problem? What if Goldbach's Conjecture was unprovable?"
18. Some of these footnotes are so weird and U.S.-reader inappropriate that it's worth giving a concrete example, such as the footnote to a line on page 41 about the narrator enrolling in a U.S. college: "According to the American system, a student can go through the first two years of university without being obliged to declare an area of major concentration for his degree or, if he does so, is free to change his mind until the beginning of the Junior (third) year," the very meaning of which is anyone's guess.
19. N.B. here that the following main-text paragraph itself is geared to a very-strong-math-background audience; nobody else is going to get the paragraph's references, and this reviewer has neither the space nor the expertise to elucidate them. So feel free to skip it if you do not fit the paragraph's demographic.
20. Unless you are yourself a professional mathematician, the best place to find a nonlethal discussion of this proof (which is known in number theory as "Vinogradov's Theorem"—that's how famous this guy was) is in Section C of R. K. Guy's *Unsolved Problems in Number Theory*.
21. You might further recall (from, e.g., Ovid's *Metamorphoses*) that this bull ends up begetting on Minos's queen the Minotaur, a hideous teratoid monster who has to be secreted in a special labyrinth and propitiated with human flesh, and who basically symbolizes the moral rot at the heart of Minos's reign. That rot is, as Joseph Campbell describes it in *The Hero With a Thousand Faces*, a certain kind of alienated selfishness:

    > The return of the bull should have symbolized Minos' selfless submission to the functions of his role. By the sacrilege of the refusal of the rite [of sacrifice], however, the individual cuts himself as a unit off from the larger whole of the community. ...He is the hoarder of the general benefit. He is the monster avid for the greedy rights of "my and mine."

22. L. Hyde, *The Gift: Imagination and the Erotic Life of Property* (1979).
23. Clearly, Petros's real sin is not "Pride" so much as plain old selfishness, Greed. It's not clear whether *UPGC*'s narrator truly fails to grasp this, or whether he is being presented as naïve, or whether the whole thing's just a translation problem.
24. Obvious though it is, Doxiadis apparently fears that his audience won't get the compact irony here, so he has Hardy then rather sniffily advise Petros "that it might in the future be more profitable for him to stay in closer contact with his scientific colleagues."