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Mathematics in Poetry

JoAnne Growney

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- Famous poets are linked to biographical entries at the Poets.org, the web site of the Academy of American Poets
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1. Poems with Mathematical Imagery

As mathematicians smile with delight at an elegant proof, others may be enchanted by the grace of a poem. An idea or an image expressed in just the right language--so that it could not be said better--is a treasure to which readers return. Particularly thrilling for me is to read a work from a poet who is fluent in the language of mathematics and uses mathematical images to make a poem vivid. I begin with a few of my favorites.

Geometry by Rita Dove

Rita Dove served as poet-laureate of the United States for the term 1993-95; here is the first stanza of *Geometry*, a poem that captures the ecstasy of discovery.

```
I prove a theorem and the house expands:
the windows jerk free to hover near the ceiling,
the ceiling floats away with a sigh.
...
```

Figures of Thought by Howard Nemerov

Poet Laureate of the United States from 1988-1990, Howard Nemerov (1920-91) served as a combat pilot during World War II. Here are lines of a poem *Figures of Thought* that gives the essence of a mathematical model.

> To lay the logarithmic spiral on
> Sea-shell and leaf alike, and see it fit,
> To watch the same idea work itself out
> In the fighter pilot's steepening, tightening turn
> Onto his target, setting up the kill,
> And in the flight of certain wall-eyed bugs . . .

If you do not have a clear picture in your mind of this curve, you may wish to explore the algebra and geometry of the logarithmic spiral and see how vividly it illuminates Nemerov's poem.

Six Significant Landscapes by Wallace Stevens

Born in Reading, Pennsylvania, Wallace Stevens (1879-1955) was, as the fragment of the poem *Six Significant Landscapes (VI)* below illustrates, one of the great imagistic voices of the twentieth century--his inventive poetry in stark contrast to the paperwork of his employment as an executive in the Hartford Insurance Company.

> Rationalists, wearing square hats,
> Think, in square rooms,
> Looking at the floor,
> Looking at the ceiling.
> They confine themselves
> To right-angled triangles.
> If they tried rhomboids,
> cones, waving lines, ellipses--
> As, for example, the ellipse of the half-moon--
> Rationalists would wear sombreros.

Probably most readers of Stevens' poem do not know the term rhomboid. You may want to guess at the meaning before you check it. What seems to be the significance of the list of mathematical figures that Stevens gives?

Pi, by Wislawa Szymborska

Winner of the 1996 Nobel Prize in Literature, Polish poet Wislawa Szymborska (1923-) is skilled at using specific details with wit and irony and offering new insights, often moral in nature. Extremely popular in her native Poland, she is persistent in her defense of individual rights. Here are the opening lines of her poem *Pi* (translated by Stanislaw Baranczak and Clare Cavanagh)

> The admirable number pi:
> *three point one four one*.
> All the following digits are also initial,
> *five nine two* because it never ends.
> It can't be comprehended *six five three five* at a glance.
> *eight nine* by calculation,
> *seven nine* or imagination,
> not even *three two three eight* by wit, that is, by comparison
> *four six* to anything else
> *two six four three* in the world.
> The longest snake on earth calls it quits at about forty feet.

Some readers find that Szymborska's use of the digits of pi have an incantatory effect. Do you also find that the numbers cast a sort of spell?

ABC, an Analytic Geometry Poem

A challenge that any word-lover may enjoy is to create a 26-word poem whose words begin with succeeding letters of the alphabet. Here is an "analytic geometry" poem *ABC* I wrote in response to that challenge. (You might try it too. Beyond mathematical topics, there are many themes with varied vocabularies that yield interesting results: for example, food or gardening--either flower or vegetable--or travel or bird-watching or a visit to the zoo.)

```
Axes beget coordinates,
dutifully expressing
functions, graphs,
helpful in justifications,

keeping legendary mathematics
new or peculiarly quite rational

so that understanding's visual
with x, y, z.
```

Gravity and Levity by Bin Ramke

There are uncounted love poems that employ the imagery of mathematics to express their passion; consider, for example, these final lines from the poem *Gravity and Levity* by Bin Ramke:

```
This is a bigger world than it was once
it expands an explosion it can't help it it has

nothing to do with us with whether we know or
not whether our theories can be proved

whether or not a mathematician
knew a better class of circles

(he has a name, Taniyama, a Conjecture)
than was ever known before before--

not circles, elliptic curves. Not doughnuts.
Not anything that is nearly, only is, such

a world is hard to imagine, harder to live in,
harder still to leave. A little like love, Dear.
```

Ramke's poem was written shortly after the Shimura-Taniyama conjecture was proved. The conjecture involved elliptic curves and was famously involved in the 1995 proof of Fermat's Last Theorem. Is love a force beyond the proofs of theorems? Beyond our imagining?

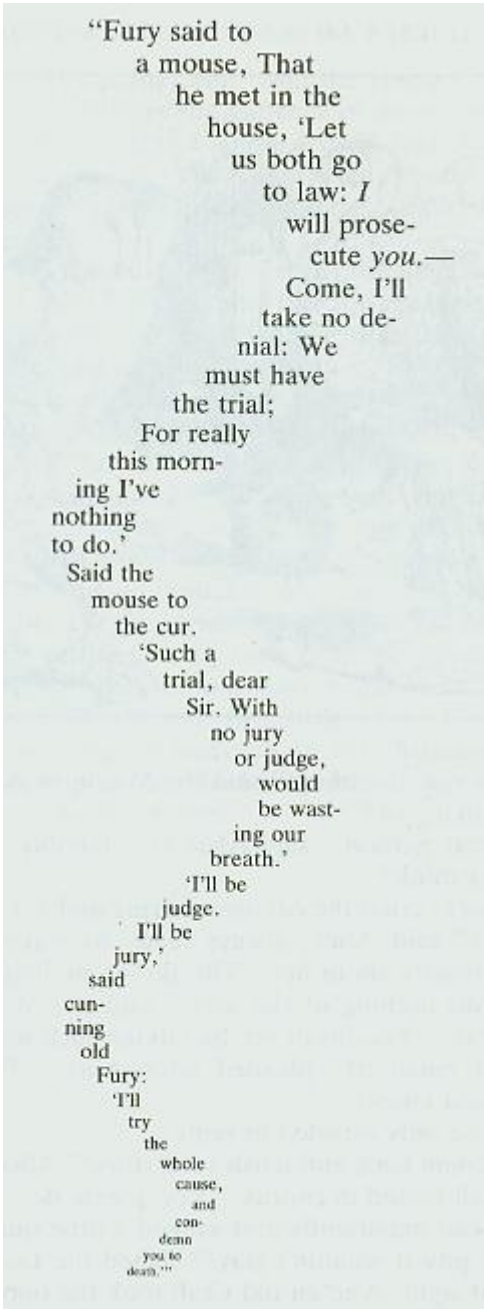
2. Poems with Mathematical Structure

One evident connection between mathematics and poetry is that of counting--poems have a chosen number of stanzas, stanzas have a number of lines, lines have a number of syllables. Beyond that, there is the shape of a poem. Often it is more-or-less a rectangle; sometimes the shape is not at all rectangular.

An Example of visual poetry: *The Mouse's Tale* by Lewis Carroll

In *Alice's Adventures in Wonderland*, the poet and mathematician Lewis Carroll tells a tale of a mouse's tail using a long-tail-shaped arrangement of words. Such a poem--which is offered in the shape of its subject--is called a *concrete poem*. A more general category is *visual poetry*--in which the shape of the poem in some general way relates to the meaning of the poem.

> "Mine is a long and a sad tale!" said the Mouse, turning to Alice, and sighing.
>
> "It is a long tail, certainly," said Alice, looking down with wonder at the Mouse's tail; "but why do you call it sad?" And she kept on puzzling about it while the Mouse was speaking, so that her idea of the tale was something like this :



A concrete, triangular poem: *More than Counting*

My triangular stanza, *More than Counting*, offered below, is a type of visual poem; its layout and content are related. This stanza also shows the sound-effect of different line lengths. If you read it aloud, you may notice how your pace changes as the length of line changes and you "feel" the shape of the poem.

```
One
added
forever
joined by zero,
paired to opposites--
these build the integers,
base for construction of more
new numbers from old : ratios,
radical roots and transcendentals,
transfinite cardinals--constructions bold!
```

A relationship between line-length and pace of a poem

To more fully understand effects of line length on the way we hear a poem, consider these next two stanzas. In the first, each line contains only two syllables. With a brief pause at the end of each line, a short-line poem moves at a slower pace than one with longer lines. This happens because it is a typical habit of reading verse to include a full line without taking a breath. The effect is best noticed when reading aloud. You might read these stanzas in your own voice or you may click on the icon to hear them read to you.

```
Short lines
like this
create
poems
through which
we move
slowly
giving
weight to
each word.

BUT, even WITH a much LONGer LINE,
my READer will READ it ALL in one BREATH--
this will SPEED the EYES aLONG the LINE
to REACH the END before the CHANCE to forGET.
```

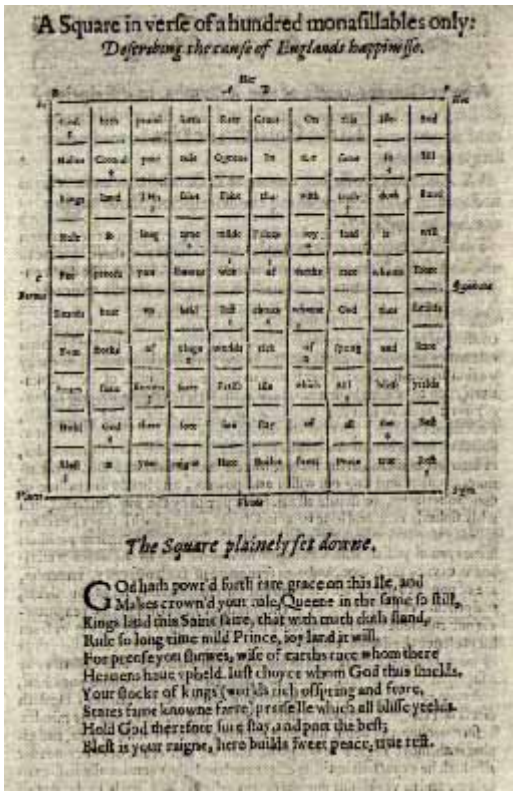
It is worth mentioning that, for a given line of verse, readers do not necessarily agree which syllables will be stressed, For example, for the first line of the four-line stanza just above, a reader might choose not to stress the initial word--instead stressing the first syllable of "**E**-ven".

Syllable counts--square poems, Haiku, and other variations

For poets as with musicians and mathematicians there is a sub- or semi-conscious inner ear that hears and keeps track of properties such as the number, the quality, and the duration of the sounds in a poem. In the four-line stanza just above, the bold-uppercase syllables designate accented or stressed syllables and there are four of them in each line. Poetry in which accents are counted is called *accentual verse*; if syllables are counted in each line we have *syllabic verse*. Poems written in English are more likely to be accentual that syllabic, but the traditional Japanese forms such as Haiku count syllables (three lines with syllable counts 5, 7, 5). Much of the poetry written in Romance languages (French, Italian, Spanish) is syllabic rather than accentual.

Although there need not be an underlying pattern for a poem, in those works that please the ear it is likely that some pattern exists. Still, just as we do not need to know the key of a musical composition to enjoy it, similar ignorance is acceptable with poetry. We will go on to explore a few *square poems* (in which the number of lines and the number of syllables per line are the same) and briefly consider other syllabic patterns.

An early example of a square poem is *A square in verse of a hundred monasillbles only: Describing the sense of England's happiness*, written in Honor of Elizabeth I by Henry Lok, shown in the graphic below:



A Square in verse of a hundred monasillables only:
Describing the cause of Englands happinesse.

The Square plainely set downe.

God hath powr'd forth rare grace on this ile, and
Makes crown'd your rule, Queene in the fame so still,
Kings laid this Saints faire, that with earth shall stand,
Rule so long time mild Prince, joy land it will.
For prese fe you flowres, wife of earths race whom there
Heauens haue vpheld, luft choyce whom God this fmelles,
Your flocke of kings (worlds rich) offspring and feare,
States fame knowne farre, prese lle which all bliffe yeelds.
Hold God therefore fure ftay, and pose the beft;
Bleft is your raigne, here builds sweet peace, true reft.

A text interpretation of the manuscript is given by Roche, who points out the complexity of the structure within the square. For example, the first and final "pillars" give a two-line verse:

```
God makes kings rule for heaue[n]s; your state hold blest
And still stand will their shields; fear yields best rest.
```

Embedded in the poem also are other poems, found by tracing the patterns of sub-squares or crosses.

Just as constraints of continuity or differentiability or preservation of distance limit the choices of functions available in a particular mathematical situation, so constraints of form or shape in a poem direct the poet toward some words while eliminating others. For example, we cannot satisfy the triangular form of *More than Counting* by starting with "number" or "develop" or any word with more than one syllable.

Mathematicians enjoy pushing against constraints to find what is possible despite their presence; I enjoy a similar struggle in poetry. For example, when I wanted to write about my decision to be polite even though somewhere inside I feel very uncivil, the constraints of a 3 × 3 square poem led me to:

```
Mock feelings
serve as well
as true ones.
```

Or, broken-hearted and remembering my mother's advice that the pain in my left eye from a grain of sand will seem to decrease if I rub my right eye really hard until it hurts, the shape restriction of a 4 × 4 square led to:

```
When lovers leave,
avoid laments.
Grab a cactus--
new pain forgets.
```

This next of my square poems, *The Bear Cave*, came from a sightseeing venture while traveling in with friends in Romania.

Twenty-five years ago at Chiscau,
marble quarry workers discovered--
trapped by an earthquake in a wondrous,
enormous cave--bones of one hundred
ninety bears, *Ursulus spelaeus*
(now extinct). Cold rooms of cathedral
splendor now render tourists breathless
while the insistent drip of water
counts the minutes. There is no safe place.

Invite someone to someone read *The Bear Cave* aloud or click on the icon to hear it read. As you listen, consider the question, *Can my ear hear that a nine-syllable line consists of nine syllables?* I doubt that many can answer *Yes*. Instead, the effect may be that the poem seems attentively organized rather than unplanned. I find a guarded, measured quality in the uniform structure of the square poem: these are not simply words but carefully arranged thoughts--and possessing solidity very different from the also-careful but fragile and imagistic Haiku. For comparison, here are two Haiku from Basho (Japan, 1644-1694), translated by Robert Hass.

The hollyhocks
lean toward the sun
in the May rain.

They don't live long
but you'd never know it--
the cicada's cry.

Translation of poetry is a topic far from the focus of this article, but in passing we mention that syllable count is one of the most difficult things to preserve when a poem is translated from one language to another. Some readers will be aware, for example, of an ongoing debate about whether the 5-7-5 syllable requirement for the Japanese Haiku is a suitable constraint to bring into the English translation. In the Haiku above, Hass gives us the delicate images in English without insistence on the 5-7-5 count.

Discussion of syllabic verse could not be complete without mention of the fine American poet Marianne Moore (1887-1972). Born in Missouri, she majored in biology at Bryn Mawr and spent much of her life in New York. She loved baseball. Counted syllables were a consistent ingredient of Moore's work. Her poem, *The Icosasphere* has three six-line stanzas in which the lines vary in syllable-count and yet the stanzas have nearly identical pattern. The poem is given below, with syllable counts at the end of each line. This sort of counting was the underpinning of Moore's legacy which combined imagination and irony with the careful observation and articulation of the scientist.

"In Buckinghamshire hedgerows (7)
the birds nesting in the merged green density, (11)
weave little bits of string and moths and feathers and thistledown, (15)
in parabolic concentric curves" and, (10)
working for concavity, leave spherical feats of rare efficiency; (18)
whereas through lack of integration, (9)

avid for someone's fortune, (7)
three were slain and ten committed perjury, (11)
six died, two killed themselves, and two paid fines for risks they'd run. (14)
But then there is the icosasphere (9)
n which at last we have steel-cutting at its summit of economy, (18)
since twenty triangles conjoined, can wrap one (11)

ball or double-rounded shell (7)
with almost no waste, so geometrically (12)
neat, it's an icosahedron. Would the engineers making one, (16)
or Mr. J. O. Jackson tell us (9)
how the Egyptians could have set up seventy-eight-foot solid granite vertically? (21)
We should like to know how that was done. (9)

Moore's poem opens with a quote from American-born graphic artist, E. McKnight Kauffer (1890-1954) whom she much admired. Toward the end of the poem she refers to J. O. Jackson who worked out a design to create a plexiglass sphere from an icosahedron by heating. Review the mathematical terms Moore uses, and then reread *The Icosasphere* with new appreciation for the contrast between the carefully designed efficiencies described before and after the "news of the day" in lines 6-9 (from the *New York Times*, December 15, 1949).

Are you able to discover a rationale for the syllable-count pattern that Moore uses? My own notion is that the existence of some sort of pattern is important--and that, in the poet's hands, this poem's content "found" or evolved into this particular pattern. For example, a short line after a very long one slows a speeded-up pace and adds emphasis to the shorter line. Look back to Moore's poem to observe this effect.

OULIPO

There are a myriad of combinatorial questions that maybe posed about poetry. For example, for a Shakespearean sonnet, how many ways are there of arranging the sonnet's lines so that the rhyme scheme is preserved? Many of us would walk away from that question with a smile, thinking it a silly one. Few if any of these rearrangements would make sense. On the other hand, there are some true things that we cannot write because they never get past our biases and our limitations--so there may be merit in a mechanical way of producing literature that could not be produced by thought alone. Enter OULIPO.

In 1960 a group of ten French intellectuals became the founding members of the OULIPO (OUvroir de LItterture POtentielle, a workshop of literary structures). The group contained musicians, mathematicians, writers, and various others. (Graph theorist Claude Berge was one of the original members.) At the center of founding members was writer and philosopher, Raymond Queneau, who described potential literature as "the search for new forms and structures that may be used by writers in any way they see fit." Queneau published a slim volume entitled *Cent Mille Milliards de poèmes* (one hundred thousand billion poems) which illustrates this formal quest. What appears at first glance to be a collection of ten sonnets is actually a base for combinatorial assembly. Each first line may be combined with each second line, and so on. Thus there are 100 possible pairings of the first two lines and, given that a sonnet has 14 lines, 10^{14} sonnets in all. (Beverly Charles Rowe maintains a website where visitors are invited to construct poems, including English translations, from Queneau's collection.)

Another Oulipo structure is the $S + 7$ Method, which takes a text and replaces each substantive word with the seventh following it in a given dictionary.

The Academy of American Poets gives an example of the $N + 7$ technique (replacing *nouns* only) applied to *The Snow Man* by Wallace Stevens. Here is the first stanza of Stevens' poem:

```
One must have a mind of winter
To regard the frost and the boughs
Of the pine-trees crusted with snow;
```

Applying the $N + 7$ rule, we get a poem called *The Soap Mandible*. Here is the new first stanza.

```
One must have a miniature of wisdom
To regard the fruit and the boulders
Of the pinions crusted with soap;
```

Examples and opinions of OULIPO are readily found on the Internet. The OLIUPO portion of the MAP site is one place to start, and provides a number of other links. A good introduction can also be found on Wikipedia.

Enumeration of rhyme schemes

Of special interest in poetic enumeration is that numbers of rhyme schemes for specified stanzas are given by the Catalan numbers and Bell numbers. For a stanza of *n* lines, the number of possible rhyme schemes is given by the *n*th Bell number. A rhyme scheme is *planar* if when pairs of end-line rhyming words in a stanza are joined by arcs, no arcs intersect. The number of planar rhyme schemes is given by the *n*th Catalan number. You can review the definition and properties of the Catalan and Bell numbers by clicking on the links above. (Martin Gardner has given readable introductions to these numbers.) For a stanza of three lines, there are five rhyme schemes, all of which are planar. For a stanza of four lines, fourteen of the fifteen possible schemes are planar and the only non-planar rhyme scheme occurs when lines 1 and 3 rhyme and lines 2 and 4 rhyme--as in these opening lines of the following love poem *Geometry* by X.J. Kennedy

```
They say who play at blindman's bluff
and strive to fathom space
That a straight line drawn long enough
Regains its stating place.
```

Several books by Martin Gardner are cited in References below. That playful philosopher who brought the fun of mathematics to so many was no stranger to poetry. He was informative not only concerning counting rhyme schemes; additionally, two of the chapters in *Penrose Tiles and Trapdoor Ciphers* introduce the personalities and methods of OULIPO.

3. References and Resources

There is no way to end a consideration of the links between mathematics and poetry. They go on and on. Recently, for example, I found a baseball poem *The Ninth Inning* by 2006 Poet Laureate Donald Hall that has 9 stanzas with 9 lines of 9 syllables. A Danish collection, *alphabet*, by Inger Christensen builds to effective climax with stanza lengths based on the Fibonnacci sequence. But I stop here and invite you to explore on your own; if you like, visit my web site Poetry, Mathematics, Art, and Translation or contact me with your ideas and comments.

References and permissions for poems and collections cited in the article

- "Geometry" by Rita Dove, from *Selected Poems*, Vintage Books, 1993.
- "Figures of Thought" by Howard Nemerov, from *The Western Approaches*, University of Chicago Press, 1975.
- "Six Significant Landscapes" by Wallace Stevens, from *The Collected Poems of Wallace Stevens*, Vintage Books, 1990.
- "Pi" by Wislawa Szymborska, translated by Stanislaw Baranszak and Clare Cavanagh, from *View With a Grain of Sand: Selected Poems*, Harcourt Brace, 1995.
- "Gravity & Levity" by Bin Ramke from *Conjunctions 35; American Poetry: States of the Art*, edited by Bradford Morrow, Bard College, 2000.
- "The Mouse's Tale" from *Alice's Adventures in Wonderland*, by Lewis Carroll, with illustrations by John Tenniel. Available online from the Classical Library.
- "ABC", "The Bear Cave" and untitled square poems from *My Dance is Mathematics* by JoAnne Growney, Paper Kite Press, 2006.
- "Haiku of Basho" from *The Essential Haiku*, edited by Robert Hass, Ecco Press, 1994.
- "Square Poem in Honor of Elizabeth I Sundy Christian Passions" by Henry Lok, from *Material Poetry of the Renaissance / The Renaissance of Material Poetry*, edited by Roland Greene, The Harvard Library Bulletin , Summer 1992, Vol. 3, No. 2. This article's image of the poem is found online at Ubu Web and is used with permission from that site.
- "The Icosasphere" by Marianne Moore from *The Complete Poems of Marianne Moore*, Penguin Books, 1981. Permission to include Moore's poem has been granted by Marianne Craig Moore, Executor of the Literary Estate of Marianne Moore.
- *Petrarch and the English Sonnet Sequences* by Thomas P. Roche, Jr., AMS Press, 1989.

- "Geometry" by X.J. Kennedy, *POETRY*, October-November 2002.
- *alphabet* by Inger Christensen, translated by Susanna Nied, New Directions Books, 2000.

Additional Poetry Resources

- JoAnne Growney--Poetry, Mathematics, Art, and Translation.
- *My Dance is Mathematics* by JoAnne Growney, Paper Kite Press, 2006.
- *Images of a Complex World: The Art and Poetry of Chaos* by Robin Chapman and Julien Clinton Sprott, World-Scientific, 2005.
- *NUMBERS AND FACES: A Collection of Poems with Mathematical Imagery*, edited by JoAnne Growney, the Humanistic Mathematics Network, 2001. An electronic copy of this anthology may be obtained from the editor, JoAnne Growney.
- *Against Infinity: An Anthology of Contemporary Mathematical Poetry*, edited by Ernest Robson and Jet Wimp, Primary Press, 1979.
- *Imagination's Other Place: Poems of Science and Mathematics*, compiled by Helen Plotz, Thomas Y. Crowell, NY, 1955.
- Mathematical Poetry by Marion Cohen
- Kaz Mazlanka's Mathematical Poetry Blog
- Mathematical Poetry - A Small Anthology, maintained by Katherine Stange
- *OULIPO: A Primer of Potential Literature*, edited by Warren F Motte, Jr., University of Nebraska Press, 1986.

Biographical References from Poets.org

- Rita Dove
- Howard Nemerov
- Wallace Stevens
- Wislawa Szymborska
- Marianne Moore
- Lewis Carroll (Charles Dodgson)
- Donald Hall

Mathematical References from MathWorld

- logarithmic spiral
- rhomboid
- pi
- icosahedron
- Catalan numbers
- Bell numbers
- elliptic curve
- Taniyama conjecture
- Fermat's Last Theorem
- Fibonacci numbers

Martin Gardner References

- *Fractal Music, Hypercards and More*, Martin Gardner, W. H. Freeman, 1992. See Chapter 2 for a discussion of Bell Numbers.
- *Time Travel and Other Mathematical Bewilderments*, Martin Gardner, W. H. Freeman, 1988. Chapter 20 gives an introduction to the Catalan numbers. See page 63 for mention of rhyme schemes and a diagram that compares planar and non-planar varieties.

- *Penrose Tiles to Trapdoor Ciphers*, Martin Gardner, W. H. Freeman and Company, 1989. Chapters 6 and 7 give an introduction to the personalities and strategies of OULIPO.