Much Ado about Zero

I find it to be quite remarkable that such an important mathematical concept as **zero** was not invented by any culture before the 4th century A.D. With the exception of the ancient Maya and the Hindu, all the great civilizations functioned without it.

In the amazing PBS documentary *Zero to Infinity* *****, which premiered November 16th 2022, the history of these seemingly opposite concepts is explored, as we learn how they revolutionized mathematics –not just once, but over and over again– as different cultures invented and re-invented them across thousands of years. Produced by Kendra Gahagan and Daniel McCabe –also its writer and director– the film's narrator, mathematician Talithia Williams, deftly shows the intriguing evolution of the concept of Zero through a series of interviews with various scientists.

According to Princeton University mathematician Manjul Bhargava, the concept of **Zero** started off in Hindu and Buddhist philosophical works as the principle of "emptiness" or "voidness" (*Śūnyatā* –Sanskrit: शून्यता). In Mahāyāna Buddhism, Śūnyatā refers to the tenet that "all things are empty of intrinsic existence." ******

During the interview, professor Bhargava explained that **"**Sometimes, when you're pronouncing things, you like to leave out a sound when you're pronouncing quickly. And so, Panini –one of the great grammarians of India– had a special symbol when a sound gets deleted. And that was called a *Lopa* [–represented by a dot.] And that's like a linguistic zero. It's very parallel to the modern apostrophe, in the English language." *****

Both the zero and the apostrophe seem to have a common origin as an attempt to symbolize a qualitative or a quantitative void, a missing letter or number, a recognition that nothing is important – (or as important as being some… thing.)

In the Bakhshali manuscript, an Indian mathematical treatise some believe to date back to the fourth century, one of the pages shows a dot, which has been interpreted to represent zero. However, there is little question that **zero** was in use in mathematics in India by the seventh century, in the time of the great astronomer and mathematician Brahmagupta.

In the early part of the ninth century, Persian scholar Muhammad ibn Musa al-Khwarizmi wrote several books which had a powerful impact on Mathematics. In one of its pages, one can clearly see the Indo-Arabic numeral system, with the original numerals, where the **zero** was simply represented by a dot : ٠١٢٣٤٥٦٧٨٩   *****

On the other hand, the apostrophe ('**'**) is a punctuation mark, and/or a diacritical mark, rather than a mathematical symbol. In English, the apostrophe is used for two basic purposes: (1) The marking of the omission of one or more letters, e.g. the contraction of "do not" to "don't"; and (2) The marking of possessive case of nouns (as in "the eagle's feathers", "in one month's time", etc.). It is also used in a few distinctive cases for the marking of plurals, e.g. "p's and q's". *******

It could be argued that omission of letters is a form of epistemic reduction, for example in the colloquial American expression "y'all" where the original "you all" diminishes the individual importance of all the persons addressed; where as the reduction of "do not" to "don't" adds perhaps an imperative tone of command via the use of the apostrophe.

The word "apostrophe" comes ultimately from the Greek ἡ ἀπόστροφος [προσῳδία], ([the accent of] turning away or elision.) ***

One could argue, however, that elision in poetry is merely a stylistic device to force a line into a prescribed meter; whereas a line break in poetry is closer to **zero** in that it creates a void that slows down the recitation of a verse so as to add depth or gravitas to the poem.

A similar expressive void is found in classic Japanese ink drawings (inspired by Zen), where the blank page becomes the empty background of the figures.

One could also interpret a lyrical silence in a song as a sort of **zero**. In order to demonstrate what I mean, I now print the first chords of *Whisper Not* –a popular jazz ballad written by Benny Golson in 1956– indicating the silent beats by red zeros:

Sing low,   **0000**
sing clear   **0000**
sweet words   **0000**
in my ear   **0000**
not a whisper of despair, but **000** loves' **000** own **000** prayer.

Sing on   **0000**
until   **0000**
you bring   **0000**
back the thrill   **0000**
of a sentimental tune that **000** died **000** too **000** soon.

One final observation: Perhaps the greatest Zero of all is the cosmic singularity or "black hole" –so infinitely powerful that it keeps our gallaxy from blowing away like the seed-crown of a dandelion; but whose matter is so infinitely dense that nothing can escape its gravitational pull, … except… Nothing.

* https://www.pbs.org/wgbh/nova/video/zero-to-infinity/
** https://en.wikipedia.org/wiki/%C5%9A%C5%ABnyat%C4%81
*** https://en.wikipedia.org/wiki/Apostrophe