

# Science was always meant to be open

Alberto Pepe<sup>1</sup>

<sup>1</sup>Affiliation not available


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Here's my crux: I find myself criticizing over and over the way that scientific articles look today. I have said many times that [scientists today write 21th-century research, using 20th-century tools, packaged in a 17th-century format](#). When I give talks, I often use 400-year-old-articles to demonstrate that they look and feel similar to the articles we publish today. But the scientific article of the 1600's looked that way for a reason. This forthcoming article by [Goodman et al. \(2014\)](#) explains:

In the early 1600s, Galileo Galilei turned a telescope toward Jupiter. In his log book each night, he drew to-scale schematic diagrams of Jupiter and some oddly-moving points of light near it. Galileo labeled each drawing with the date. Eventually he used his observations to conclude that the Earth orbits the Sun, just as the four Galilean moons orbit Jupiter. History shows Galileo to be much more than an astronomical hero, though. His clear and careful record keeping and publication style not only let Galileo understand the Solar System, it continues to let anyone understand how Galileo did it. Galileo's notes directly integrated his data (drawings of Jupiter and its moons), key metadata (timing of each observation, weather, telescope properties), and text (descriptions of methods, analysis, and conclusions). Critically, when Galileo included the information from those notes in *Siderius Nuncius*, this integration of text, data and metadata was preserved:

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But on January 10th the stars appeared in the following position with regard to Jupiter; there were two only, and both on the east side

Ori.                      \*        \*                Occ.

of Jupiter, the third, as I thought, being hidden by the planet.

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The beautiful figure above is a snapshot (translated to English) of the *Sidereus Nuncius* ([Galilei, 1610](#)), a paper Galilei published just over 400 years ago. What can we learn from it? All the data that Galileo collected (his own drawings of Jupiter and the moons), together with metadata (times of observations) were fully included in the final published paper. In other words, one of the fundamental papers for our

understanding of our place in the universe is essentially an *open* annotated scientific notebook.

The scale of the data, analysis, and code we produce and handle today in most disciplines is so large that it simply "does not fit" in a paper as it did in Galileo's times. So the papers we end up publishing become rather superficial, high-level accounts of science that fail to open and expose the raw materials of research. Whereas Galileo published annotated scientific notebooks, today we publish annotations *without* a scientific notebook.

It's time to re-imagine the scientific article. And at Authorea, we are excited to be paving the way. Our mission? To enable the article of the future: a living, breathing, forkable Git repository which seamlessly connects text, images, data, code, and notebooks, [like this](#).

So, were he alive today, what would Galileo publish?

## References

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