The power of illustration

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My first scientific paper appeared in 1988 when I was a graduate student at Cambridge University's Institute of Astronomy.[1] Among the paper's figures was a cartoon-like illustration of a close binary star system, Hercules X-1. One of the two stars, HZ Herculis, is puffed up to fill its Roche lobe—that is, the teardrop-shaped surface in the system's rotating frame that marks the limit of the star's gravity to retain material. The other is a neutron star, which sits at the center of an accretion disk. The disk is fed by plasma from the photosphere of HZ Herculis. By the time the plasma reaches the neutron star, it's so hot that it glows in the x-ray band.

I did not draw the illustration myself, nor did I use drafting software. Rather, it was created by Richard, the artist retained by the institute.

Most of the illustrations you see in PHYSICS TODAY are created by the magazine's art department, which consists of Donna Padian, the art director, and Freddie Pagani, the art and production associate. Donna and Freddie also redraw artwork. Sometimes that's because an author draws a crude sketch and seeks professional help, as I did. But other times, they redraw an illustration because the original is, well, too crummy for a self-respecting magazine to publish.

Good illustrations aid understanding. Among my favorites are the ones in the classic textbook *Molecular Biology of the Cell* by Bruce Alberts and six coauthors. Biomolecules are transparent. If human vision could somehow circumvent light's diffraction limit and allow us to see biomolecules interacting, they would resemble mating jellyfish. But in the book, they are rendered as blobs of different shapes and colors. A biophysicist, whose name I forget, once told me that each illustration was, in effect, a PhD thesis problem—that is, a challenge to understand and quantify the interactions embodied in the artwork.

Out of curiosity, I checked arXiv.org to evaluate the prevalence and quality of explanatory illustrations in my old field, astronomy. The first thing I noticed was that the preprints were all formatted to match the article templates of their intended destinations: *Astronomy & Astrophysics*, *Astrophysical Journal*, *Monthly Notices of the Royal Astronomical Society*, and—new to me—white papers that will inform the upcoming decadal survey from the National Academies of Sciences, Engineering, and Medicine. The papers and the data plots they contained looked impressively publication-ready.

For my investigation, I had looked at the most recent 20 papers in the catch-all category, astro-ph. Only two in the sample had explanatory illustrations. One of them appeared as figure 1 of a preprint by Anusha Kalyaan and Steven Desch of Arizona State University.[2] It consists of three panels that nicely depict the subject of their investigation: the transport and distribution of water in protoplanetary disks. As if to emphasize its power to inform, the figure is accompanied by a caption of 266 words.

This past February, I encountered another helpful illustration. It came from a 2008 paper, "High- and low-velocity magnetized outflows in the star formation process in a gravitationally collapsing cloud," by Masahiro Machida and Shu-ichiro Inutsuka of Kyoto University and Tomoaki Matsumoto of Hosei University in Tokyo.[3] I consulted the paper because it provides a theoretical explanation of a recent observation from the Atacama Large Millimeter/Submillimeter Array,[4] which was the subject of an online news story I was writing.

The illustration was the last figure in the paper. The 14 that preceded it were technical graphs, mostly from the numerical simulations that form the paper's basis. By contrast, the schematic was a cartoon-like representation of the paper's principal finding: that the two types of outflow from protostars—slow and wide, and narrow and fast—originate at different stages in the protostar's evolution. Depicting both outflows together in the same illustration, even though they're separated in time by hundreds of thousands of years, might not seem to make sense physically. But because the two outflows are often observed together, the illustration served as a visual embodiment of the paper's aim: to explain what astronomers see.

References

1. C. S. R. Day, A. F. Tennant, A. C. Fabian, *Mon. Not. R. Astron. Soc.* **231**, 69 (1988).
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3. M. N. Machida, S. Inutsuka, T. Matsumoto, *Astrophys. J.* **676**, 1088 (2008).
4. Y. Matsushita et al., *Astrophys. J.* **871**, 221 (2019).

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