Visualising Astronomy: Visualising Exoplanets

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In my previous column[1], I described some of the varied means of diagramming the data about exoplanets and exoplanetary systems. Frankly, however, those methods don't do justice to the bigger picture: we need a wider range of tools to help people grok[2] (to understand intuitively) what astronomical observations have revealed. (Normally, I use the term "visualisation" to refer to the visual representation of data, but I'm going to relax that a little in this context; instead, I'll interpret the word in its more commonplace usage of creating a mental image.) How can we help people comprehend the scope, the breadth, and the impact of the spectacular observations of planets around other stars?

When it comes to imaging other worlds, space art blazed the trail more than fifty years ago.... The term applies to a variety of content from highly imaginative covers of science fiction paperbacks of the last century to deeply informed recreations of astronomical objects. The International Association of Astronomical Artists (IAAA) website[3] offers a glimpse at the range of work, as well as a peek into the history of the medium.

In his 1978 essay, "The Archeology of Space Art," Ron Miller wrote, "*Contemporary artists certainly have more factual material to draw upon, yet this abundance also limits them. [...] The phrase 'artist's impression' attached to a space painting no longer means an imaginary guess.*"[4] When Miller wrote those words more than three decades ago, he applied his thinking to objects in the Solar System — consider how radically the *Voyager* and *Pioneer* missions transformed our view of other planets — and his words date to a period when actual spacecraft imagery had started to approach artists' representations in terms of quality. And as Miller specifically notes, discoveries made by those spacecraft put constraints on the artists' work (e.g., the Moon doesn't have mountains the likes of which Chesley Bonestell painted in his famous *Colliers* series from the 1950s) that remove them from occasionally more fanciful work of their predecessors. Furthermore, by the time of Miller's writing, the space programme had shifted from human exploration (always a staple of space art) to robotic voyages: a transition from the aspirational ("we will go there") art of the 1950s and 60s to the inspirational ("wouldn't it be nice to be there") art of the 1970s and 80s.

Established space artists including Lynette Cook and David A. Hardy (to choose just two examples) have lent their images to press releases about exoplanets. Indeed, Hardy's image of tau[1] Gruis (Figure 1) strikes me as an almost prototypical example of the genre: the viewer, placed on the surface of a solid body (in this case, the hypothetical moon of an exoplanet discovered by the Anglo-Australian Planet Search), takes in a dramatic vista that incorporates the rugged (exaggerated) terrain of the moon, the visual counterpoint of the ringed planet and the angular foreground, and the highly expressive whorls of the giant planet's clouds.

Coming at the challenge from a different direction, I personally have helped visualise two different exoplanets (and one exoplanet's hypothetical moon) for public planetarium shows, most recently Gliese 581d for the California Academy of Sciences opening show, *Fragile Planet* (Figure 2). Dimitar Sasselov, Director of the Harvard Origins of Life Initiative at the Harvard-Smithsonian Center for Astrophysics, advised on the ratio of water to land, the amount of cloud cover, and the distribution of ice on the surface of the "super Earth." Based on his input, we used an array of animation tools to create the sequence, with particular reliance on Terragen™[5], software originally designed for digital matte painting in the film industry. The final images appeared mapped onto a sphere with appropriate atmospheric effects generated by Uniview software[6], integrated into a Keplerian planetary system with orbits based on the observed characteristics of the Gliese 581 system, then placed into the Hipparchos star catalogue at the star's proper location.

That type of process exists firmly within the realm of science visualisation, albeit driven by a more subjective set of criteria than a typical project, which usually has fewer degrees of freedom in terms of conveying a concept. (I often joke that the challenge of visualising astronomical data boils down to deciding what colour to make the invisible gas.) And like much contemporary visualisation, the scene exists as part of an animated sequence — in this case, fulldome video.

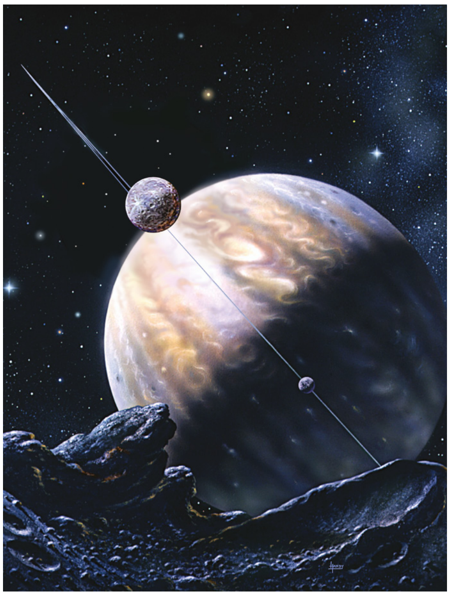

***Figure 1.** Artwork from a 2002 press release describing the "detection of a Jupiter-mass planet orbiting tau[1] Gruis" exists squarely within the space art tradition of imagined landscapes. Credit: PPARC and David A. Hardy.*

Most contemporary exoplanet illustrations owe a bit to both space art and visualisation. For example, in Greg Bacon's depiction of HR 8799b (Figure 3), we view a ringed planet from the surface of a hypothetical moon, but the moon takes on an appearance reminiscent of the Galileo images of Ida or the Deep Impact images of

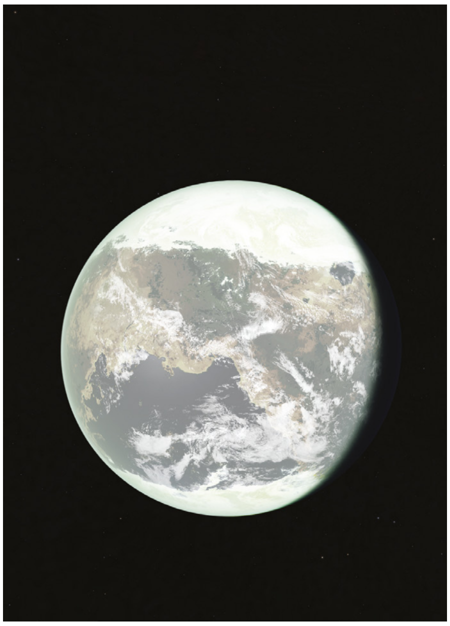

Figure 2. A still image from the planetarium show Fragile Planet illustrating a chilly but water-covered Gliese 581d, based on input from an exoplanet specialist and integrated into the three-dimensional Hipparchos database. Credit: California Academy of Sciences.

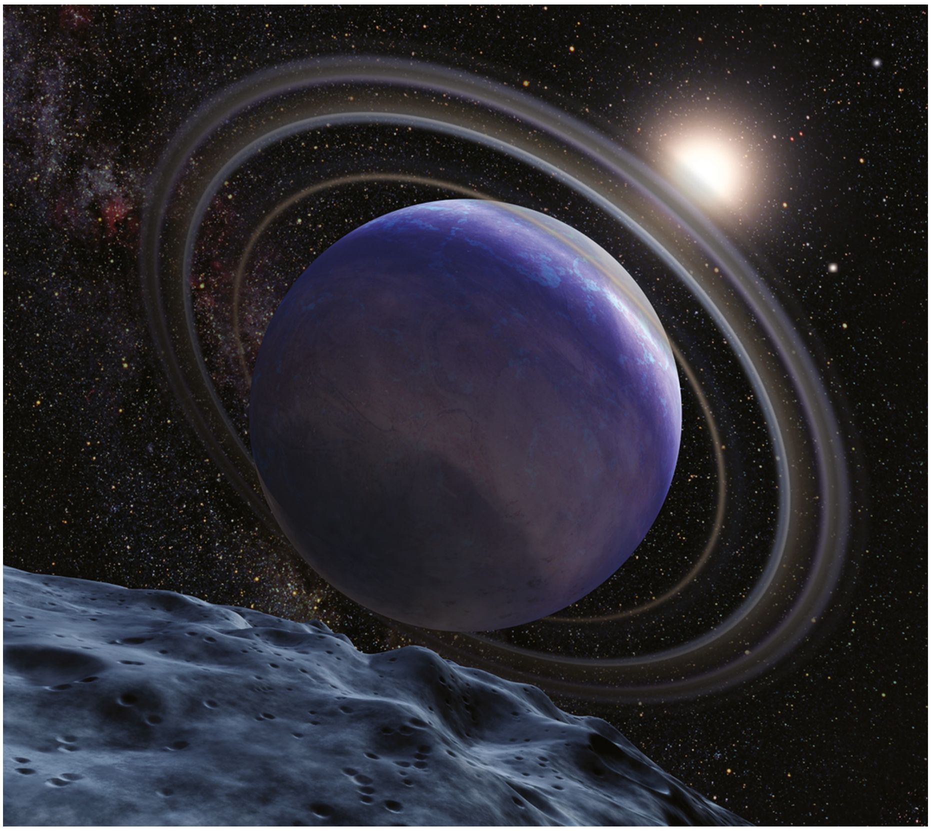

Figure 3. The "artist's concept" that accompanied the Hubble press release about archival data refining our knowledge of HR 8799b. Credit: NASA, ESA, and G. Bacon (STScI).

Tempel 1. But the whole scene sits in front of a photorealistic Milky Way, with the other planets in the system visible as points of light against the background stars[7].

(A detail I can't resist addressing ... Hardy favours a bit of accuracy over drama by depicting a moon that lies in the ring plane of its parent planet, as one would expect. Bacon chooses a more sensational perspective on his ringed world by placing the moon outside the ring plane — a less plausible configuration, but the asteroid-like appearance of the moon suggests a captured body that could exist in an inclined orbit.)

Most of the images that illustrate exoplanet press releases actually involve many more constraints than those Miller decried. The artwork often needs to communicate a specific concept tied to the discovery (e.g., the derived characteristics of the planet, the multiplicity of planets in the system) and sometimes needs to avoid suggesting a potential future discovery (e.g., the existence of an exomoon). As Robert Hurt, of the Spitzer Science Center, puts it, "As the science advances, a second paper can completely overturn the ideas in the previous one, so a carefully constructed visualisation based on one result is often later superseded by a radically different image ... perhaps a reminder that spending weeks to match the science carefully may be over-thinking the problem."[8]

I find it intriguing that exoplanet artwork — er, visualisations — reside in this overlap between new and old ways of imagining other worlds. It should come as no surprise, really, since we operate in a blissful state of combined ignorance and imagination. And we can expect this situation to persist for some time, because we can never visit these exoplanets, never subject ourselves to the same kind of specific constraints that the space artists of the 1970s faced with the rapidly-returning results from spacecraft missions throughout the Solar System. Instead, the exoplanet images that accompany press releases will continue to play the role that space art once played for a generation of enthusiasts, fuelling the excitement for discoveries about the Universe around us.

Notes

1 Wyatt, R. 2011, Visualising Astronomy: Visualising Exoplanet Data, CAPjournal, 11, 32

2 Heinlein, R. 1961, Stranger in a Strange Land, (London: New English Library Ltd)

3 http://iaaa.org/

4 Miller, Ron 1978, Space Art, p. 10 (retrieved from http://dreamsofspace.nfshost.com/spaceart.htm on 12 February 2012)

5 http://www.planetside.co.uk/

6 http://scalingtheuniverse.com/

7 http://hubblesite.org/newscenter/archive/releases/2009/15/image/d/

8 Hurt, R. 2012, Private correspondence, 15 Feb 2012.

Biography

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