

Einstein, Picasso, and Cubism: 'Seeing' the Fourth Dimension

The review by Stephen G. Brush of Arthur I. Miller's book *Einstein, Picasso: Space, Time, and the Beauty That Causes Havoc* (PHYSICS TODAY, December 2001, page 49), prompts me to add some comments.

Pablo Picasso did not invent cubism. Paul Cezanne was painting cubist paintings, in all but name, by the mid-1880s. Objects were analyzed and reduced to basic geometric forms, often to aggregations of flat planes, and were seen from more than one angle of perspective in many of Cezanne's works. Picasso himself did not turn to cubism before seeing the great Cezanne show of 1906, shortly after Cezanne's death, and often spoke of his reverence for the older artist.

Les Femmes d'Alger was painted in 1907, as is stated in the article, but was not publicly exhibited until years later. If not the first cubist picture, it was certainly the most shocking one at the time. Even Picasso was a little afraid of it; for 15 years after he'd painted it, he showed it only to friends.

While the review states that both Picasso and Albert Einstein held that "thinking, not seeing, leads to the truth," Einstein reported differently: While still a teenager, he imagined himself riding on a beam of light and wondering about the consequences of it. This implies that the vision, albeit an internal one, preceded the thought. Einstein often emphasized that the idea preceded the thought. Thus his perception of nature, or his "seeing" of nature in a deep sense, was the necessary forerunner of all the thinking that followed.

And Cezanne's finely wrought cubism came from seeing, which he always stressed as paramount when painting from nature. He suggested

that truly seeing could give birth to a closer re-creation of what the eye and mind actually perceive than could a classical Renaissance perspective.

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The review of Miller's book propagates a misconception by referring to the fourth dimension as "time, not space," repeating a comment from H. G. Wells. The fourth dimension appears explicitly as part of a displacement in spacetime, and has the form of not simply t , but rather ict , which is orthogonal to the other three classical spatial dimensions. The factor c puts all four dimensions on the same footing in the algebra of relativity.

The book's purported correlation between relativity and modern art is reminiscent of the old saying about the correlation between the price of rum and the salaries of Presbyterian ministers. Almost any two things can be correlated by selecting some specious reasoning to make the correlation plausible, or by invoking faith. Astrology is a familiar example.

Lastly, the illustration printed with the review looks flat to me, lacking the perspective to suggest a third dimension, much less a fourth. If someone sees a fourth dimension here, perhaps others may see five, six, or more. Picasso painted many fine portraits with lifelike proportions and normal perspective. He knew what he was doing when he flattened the human subjects in his cubist paintings, but the results must be interpreted in our imaginations, not in the objective analysis of science.

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BRUSH REPLIES: These two letters illustrate how, in the century since Einstein and Picasso made their startling discoveries, physics and art have grown further apart. Richard Tourin gives a critique of four-dimensional representations of the world, while Charles Zigmund

wants to award Cezanne the credit for inventing cubism.

Arthur Miller has something important to say to both correspondents: Einstein and Picasso lived in a culture that was fascinated by the concept of a fourth dimension and how it might offer a clue to the nature of a world that is not completely or directly visible to us. Miller offers documented personal connections, not just statistical correlations; and he shows in detail how the two geniuses developed their ideas, following similar though separate paths. If you want to argue about whether Picasso could "see a fourth dimension" as he worked on *Demoiselles* or whether "truly seeing" a beam of light requires some kind of thinking (not just collecting the raw visual sensations available to everyone), you will find Miller's book useful.

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Acoustic Surgery Devices in Clinical Trials

Gail ter Haar's article "Acoustic Surgery" (PHYSICS TODAY, December 2001, page 29) is admirable in describing bloodless, nonincisional surgery, a goal long desired by medical technology workers. Her description of magnetic resonance-guided focused ultrasound surgery (MRGFUS), however, understates the accomplishments of this approach. With MRGFUS, the focused beam is seen directly at lower power (magnetic resonance imaging can be sensitive to temperature changes of 1–2°C), thus permitting the surgeon to position the treatment beam accurately. MRI is also the most sensitive method for defining the target so that the surgeon can see, for example, tumor margins. Precise closed-loop control of the treatment, without damage to healthy tissue, is thereby obtained. These systems are

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commercially available, and human clinical trials are under way at multiple sites in the US.

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The article by Gail ter Haar presents an excellent review of the history and current status of acoustic surgery, and describes the renewed interest and newest applications of high-intensity focused ultrasound (HIFU). Unfortunately, ter Haar neglects to mention outstanding contributions, dating back more than 30 years, from a group at the Indiana University School of Medicine in Indianapolis.

In 1970, researcher Frank Fry and neurosurgeon Robert Heimbürger began treating terminally ill brain-cancer patients with Fry's HIFU device, which was coupled with a highly accurate B-mode imaging system.¹ Fry and Heimbürger continued to improve the HIFU technology. Then, in consultation with Indiana's department of urology, Fry and I developed a prostate ablation device² that combined both imaging and HIFU treatment within a single ceramic crystal, thus eliminating transducer alignment complications. This device was approved in the US and Europe in 1992 for treatment of benign prostatic hyperplasia,³ and has been used by my company to treat BPH patients for several years. Unlike the "disappointing" results ter Haar mentions, multisite phase-III clinical trials demonstrate that HIFU treatment is safe and effective, improves peak urinary flow, reduces symptom scores, and improves quality of life.

References

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2. R. Bihrlé, R. S. Foster, N. T. Sanghvi, J. P. Donohue, P. J. Hood, *J. Urol.* **151**, 1271 (1993).
3. M. Marberger, *Eur. Urol.* **23**[S1, suppl.] (1993).

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TER HAAR REPLIES: The comments made by Kirby Vosburgh and Narendra Sanghvi are well taken. In a brief overview, it is impossible to mention all the contributors to this

field. A review article can only be a personal judgement regarding the major milestones in a technique's development. The researchers in Indiana have certainly made significant contributions, but so too, for example, did Padmakar Lele at MIT, John Pond at Guy's Hospital, London, and, more recently, Dominic Cathignol's group in Lyon, France. There was simply not the space to detail these contributions, nor those of many other notable researchers.

I did not mean to understate the role of magnetic resonance imaging in acoustic surgery; I recognize and am excited by its considerable potential. The ability to image 1–2°C temperature rises, while useful, must not be overstated, because without good understanding it may lead to mispositioning of the high-power focus. The strength of MRI-guided acoustic surgery lies in its ability to overlay, on an anatomical image, the distribution of thermal dose achieved, thus allowing an essentially real-time assessment of the treatment. Ultrasound techniques do not yet provide such information, but may in the future. Undoubtedly there will be clinical applications—for example, in the brain—for which MRI will be the best way to monitor treatments, but for many others, diagnostic ultrasound will prove to be more appropriate. Certainly, because of the expense of, and limited access to, MR scanners, acoustic surgery that is ultrasound guided will be available to more patients worldwide.

Clinical interest in acoustic surgery is expanding rapidly; concurrently, many commercial enterprises are appearing, some farther down the road to regulatory approval and commercialization than others. The devices mentioned by Vosburgh and Sanghvi are just two of several currently in clinical trial. I considered it beyond the scope of the article to review the information available from these sources.

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Bell Labs Had Role in EDFA Development

The interesting recent article on Bell Labs, Lucent Technologies (PHYSICS TODAY, October 2001, page 26), omitted an important detail. Although the article lists some of Bell Labs' major achievements,

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