

2. V. M. Strutinsky, *Sov. J. Nucl. Phys.* **3**, 449 (1966).
3. H. J. Speccht, J. Weber, E. Konecny, D. Heunemann, *Phys. Lett. B* **41**, 43 (1972).
4. P. A. Russo, J. Pedersen, R. Vandenbosch, *Nucl. Phys. A* **240**, 13 (1975).

ROBERT VANDENBOSCH
University of Washington
Seattle, Washington

1/92

'The Starry Night' Illuminated

I was pleased to see Scott Tremaine's apt use of Vincent van Gogh's "The Starry Night" to illustrate his article on dark matter in the universe (February, page 28). Van Gogh painted it while in a sanitarium in Saint-Rémy, France, and Tremaine says it "suggests how the night sky might look if all the mass in the universe were luminous."

As a footnote, it may interest your readers to know that Albert Boime¹ (working with the late George Abell) and I² independently concluded that this is one of several sky views based on van Gogh's own observations. In one case, "Starry Night on the Rhône"—not the painting used by Tremaine, but an earlier one that includes the Big Dipper—it is clear that van Gogh conflated a southwest view of the Rhône landscape with a northern view of the sky. In fact, the orientation of the Dipper and its height above the horizon are consistent with the known place and approximate time of the painting. Another painting, "Road with Men Walking, Carriage, Cypress, Star and Crescent Moon," has been analyzed by Donald Olson and Russell Doescher,³ who used a computer "planetarium" to conclude that it accurately depicts the new Moon, Venus and Mercury in the evening sky in mid-May 1890, several months before van Gogh's death.

The Saint-Rémy "Starry Night" is a conflation of views, I believe. Van Gogh's letters⁴ and contemporary weather records let us date the painting to 15–18 June 1889. The brightest object near the horizon, just to the right of the tree, is Venus, seen as a morning star in the eastern sky and mentioned in a letter to his brother, Théo. The Moon would also have been seen in the pre-dawn sky, although van Gogh appears to have taken some liberties with the shape of the crescent. The stars and the swirling nebulous pattern may have been patterned on the southeastern evening sky at that time. In a letter from the previous summer, van Gogh de-

scribes the "blue-whiteness" of the Milky Way, which he would have seen in June through the window of his east-facing room on the second floor of the sanitarium. The village in the foreground of the painting is pulled in from a view to the south, which was not visible from his window but could be seen from the garden of the sanitarium.

In trying to account for the spiral pattern—which, of course, needs no such explanation, but who can resist the temptation?—it is interesting to note that Camille Flammarion's popular book⁵ (and a variety of articles) had reproduced the drawing of the Whirlpool nebula by Lord Rosse (William Parsons). Flammarion wrote: "This structure recalls so well that of our Milky Way, which surrounds us on all sides, that we can see in it an image of our universe resembling those that are often shown in astronomical treatises. If we suppose ourselves to inhabit the central regions of this distant universe, we would no doubt see a Milky Way surrounding our sky and reproducing the sidereal effects that we see from our floating island." Van Gogh's painting is remarkably similar to Lord Rosse's drawing, and although we have no evidence that van Gogh (who was a voracious reader) actually saw Flammarion's book, I like to think that he is giving us a double view of our galaxy.

Van Gogh's letters are a fascinating record of an artist in search of "truth." He expresses a fear of letting his imagination run wild, and yet he insisted on seeing beyond the surface. To me, they reflect a tension similar to the attitude of the research scientist, who must use imagination to clarify vision and yet cannot afford to be carried away.

In any case, van Gogh was an avid amateur of the sky. To his brother he wrote: "Looking at the stars always makes me dream, as simply as I dream over black dots representing towns and villages on a map. Why, I ask myself, shouldn't the shiny dots of the sky be as accessible as the black dots on the map of France? Just as we take a train to reach Tarascon or Rouen, we take death to reach a star."

References

1. A. Boime, *Arts Magazine*, December 1984, p. 86.
2. C. Whitney, *Art History* **9**(3), 351 (1986).
3. D. Olson, R. Doescher, *Sky and Telescope*, October 1988, p. 406.
4. V. van Gogh, *The Complete Letters of Vincent van Gogh*, New York Graphic Society, Greenwich, Conn. (undated).

5. C. Flammarion, *Les Etoiles*, C. Marpon et E. Flammarion, Paris (1882).

CHARLES A. WHITNEY
Harvard-Smithsonian Center
for Astrophysics
Cambridge, Massachusetts

2/92

Is Science Made Too 'Magical' to Children?

Thank you for organizing the special issue on pre-college education (September 1991). The issue makes the point very well: This subject is *not* beneath the dignity of practicing physicists.

However, the cover photo (and several others accompanying the corresponding article) illustrates well one of the primary shortcomings of our attempts to educate children in science: Too often we misjudge our targets, and our message gets badly mangled. The cover shows a friendly young physicist (good so far), dressed casually (no tie, no lab coat—still good), in a laboratory crammed with electronics (maybe intimidating to kids, but let's see . . .), doing an experiment with a bunch of third-graders, using a plastic wading pool, a toy boat and some balloons (good). Obviously he is going to attach the balloons to the boat in a simple way and propel the boat with balloon power, thus demonstrating conservation of momentum, conversion of energy from air compression (via the lungs) to kinetic energy of the boat, and so on, all using familiar materials from the children's macroscopic world. He is going to show them that their world can be understood in terms of simple concepts that they can handle, even as children.

But *no!* We learn from the caption that instead he is teaching them about energy conservation by using a "shape-memory wire" affected by thermal differences between ice and water. The balloons were for another experiment, using liquid nitrogen. These kids are not familiar with such esoteric concepts as "shape memory" or such esoteric materials as liquid nitrogen. They surely came away from this demonstration with the idea that science is something that goes on in laboratories only, not in the real world. They surely thought that it involves magic: something incomprehensible (see how this wire uncoils as it warms!) that happens when somebody in the "priesthood" (the physicist) does something. They surely thought: "Gee whiz! That's neat! Show us another trick!" They might well have thought: "Who cares! Real boats don't run like that."

The problem here is that despite the best intentions, the execution was faulty because the target was misjudged. Third-graders are not ready for complex concepts like "shape memory"; when we try to teach complexity to them, they regard it as magic or as delivered wisdom. They do not see it as a commonly occurring phenomenon in their world, something that is amenable to understanding. They do not see that by first mastering balloon power and boat motion, they can lead themselves to mastering an understanding of other features of their world. They do not see the amazing edifice of understanding that science has built, how one can know the universe by building understanding brick by brick.

Instead they see a *complex* phenomenon: a balcony high upon the edifice. They see no connection between that and their own world, outside the electronics laboratory. They think, "That stuff is neat, but too mysterious for me, and besides, who cares?" We need to teach science to third-graders using materials from their own world, examples that appear relevant and concepts that they can handle. We should save the liquid nitrogen for junior high school and the shape-memory wires for physics majors in college.

LEON THOMSEN
Tulsa, Oklahoma

10/91

THE PHYSICIST SHOWN ON THE SEPTEMBER 1991 COVER AND A COLLEAGUE REPLY: Mysteries are great drivers of curiosity and investigation. They motivate a search for solutions. Indeed, a group of elementary school children were recently drawn to their school library in an attempt to uncover the secrets of a magician's tricks. They wondered what it was that they were seeing, because they knew that it was not actual "magic." Whether presented with sleight-of-hand tricks or demonstrations of physical phenomena outside their daily experience, students are inspired in their amazement to ask questions and to look further.

A program such as the one pictured on the cover of the September 1991 issue of *PHYSICS TODAY* is not intended to take the place of a comprehensive course of study. Instead, it engenders an excitement about the process of physical inquiry. Examples from the students' everyday experience are used to introduce concepts. In fact, most demonstrations must yield concepts that firmly anchor themselves in the students' current level of physical understanding. However, some real stumbers are necessary to create

the sense of mystery that promotes questioning.

The boat shown on that cover is very simple in form: a hull, a cover and a single loop of wire around two pulleys (one of which paddles the boat). One need not understand the complex concept of martensitic transformation, which underlies the function of the shape-memory wire, to understand that the boat is powered by an ice cube. No battery. No rubber band. Nobody pushing. Pretty amazing. Then the question: What does temperature have to do with movement and energy? The examples from everyday life flow forth.

A balloon-powered boat is a great idea. Children are hungry for people who can lift ideas out of the pages of books and into their lives. We encourage all readers who feel that they have something to share to go out into their local schools and coordinate their efforts with the teachers. If you make your presentations with a spark in your eye, you may find that the enthusiasm is contagious—both yours and the students'.

ERIC D. MARSHALL
IBM Thomas J. Watson Research Center
Yorktown Heights, New York
KATHERINE R. MCKENNA
Pawling Elementary School
Pawling, New York

5/92

Why Johnny and Janey Can't Think

As a graduate student working toward my PhD in applied physics, I am concerned about the dangerous lack of quality in physics and mathematics education in our nation.

Kids today do not know how to think critically. Colleges and universities are filled with examples. I teach a laboratory course at a medium-size Eastern state university. The class is designed to complement a first-year physics sequence for future scientists and engineers. Students are given handouts that contain both a non-cookbookish procedure and a survey of the theory behind the experiment. The procedure is not "step by step" on purpose: Our idea is to place the student in a situation where he or she must reason about how to use unfamiliar equipment to measure physical quantities.

Unfortunately, students do not come prepared to solve the new types of problems presented in the lab setting. They seem incapable of reasoning out the questions they come across. More often than not they seem *unwilling* to reason. Many

times they fail to identify important questions. Students are invariably under the impression that they will be told everything they need to know and won't have to struggle with anything themselves.

One of our experiments uses an instrument with which few if any students are familiar: the oscilloscope. Surprisingly, students seem to be terrified of this nearly unbreakable instrument. I don't think this is a case of "high-tech anxiety"; many stereo and TV systems are much more complicated. The students' terror comes from the realization that they have been presented with unfamiliar equipment and that they themselves are largely responsible for making the experiment fly.

It is my opinion that students can't figure out the oscilloscope because they do not *try* to figure it out. Students don't approach it with a system of trial and error. Instead of learning what the knobs, dials and displays do and mean, they memorize rules about how to make the instrument work. They have been taught by repetition, as well as reward and punishment, to perform a type of blind monkey-see-monkey-do.

I believe that these attitudes stem from the earliest "educational" experiences kids are exposed to in the US. Teachers in elementary and high schools mainly want kids to behave, to be quiet and not to do—or think about—anything they are not supposed to. This is largely detrimental to education. Paraphrasing the people who have played major roles in my own education, *chaos* is a necessary condition for learning. A person only learns what he or she is interested in and what that person believes is important to himself or herself. Further, since not all individuals ascend the educational staircase with the same zest and speed, why must all students be forced at intellectual gunpoint to conform to the same thoughts, expectations and lesson plans?

What are the solutions to the various pressures and problems that compel teachers to adopt this approach? To begin with, I believe teachers could certainly use trained help in the classroom. This would help to eliminate discipline problems. It also would allow students to receive more individualized attention. Qualified aides could encourage kids to think about things that a single teacher could never begin to encourage.

University instructors should develop pre-college programs stressing

continued on page 85