

# Mathematical Moments

— a series of over 60 posters that describe the role mathematics plays in science, nature, technology, and human culture.



- Display in your office or in common areas
- Use in the classroom
- Listen to podcasts of “Making Movies Come Alive,” “Predicting Storm Surge,” “Finding Fake Photos,” and others
- Read translated versions in Spanish, French, German, Polish, Russian, Chinese, Japanese, Portuguese
- Learn how math is applied in fields such as medicine, space exploration, biology, computer science, architecture, ecology, animation, archaeology, ...

View, download, and print all the Mathematical Moments at [www.ams.org/mathmoments](http://www.ams.org/mathmoments)



**Sailing Faster**  
A lot of work takes place on the water in competitive racing. The secret is a great deal of work done on land designing a boat's hull and sails years before the starting gun even sounds. Much of the process of creating a 20-ton vessel that must move efficiently through air and water involves mathematics—specifically the theory of fluid flow. In fact, roughly 40 million equations are used in the design of today's America's Cup yachts to ensure that their crews sail the fastest boats possible.

**Tripping the Light-Fantastic!**  
Invisibility is no longer confined to fiction. In a recent experiment, microwaves were bent around a cylinder and returned to their original trajectories, rendering the cylinder almost invisible at those wavelengths. The discovery means that we're ready for invisible humans (or spacecraft), but by using Maxwell's equations, which are partial differential equations fundamental to electromagnetics, mathematicians have demonstrated that in some simple cases not seeing is believing, too.

**Finding Fake Photos**  
Actually, they weren't caught together at all—their images were put together with software. The software clued by the stars' faces gives it away. The sun is coming from two different directions on the same beach! How elaborate digital doctoring is detected with mathematics. Calculus, linear algebra, and statistics are especially useful in determining when a portion of one image has been copied to another or when part of an image has been replaced.

**Reconstructing Faces**  
A new application of mathematics allows surgeons to plan reconstructive facial surgery by analyzing various operative strategies implemented on virtual three-dimensional models. Previously, replicas constructed from CT scans were used, which were expensive and allowed only one surgical strategy per replica. The new virtual models use geometry, partial differential equations, and numerical analysis to represent the movement of bone and soft tissue associated with different options, so that surgeons and their patients see the predicted results and choose which best.

**Putting Music on the Map**  
Mathematics and music have long been closely associated. Now a recent mathematical breakthrough uses topology (a generalization of geometry) to represent musical chords as points in a space called an orbifold, which twists and folds back on itself—much like a Möbius strip does. This representation makes sense musically in that chords that are far apart in one sense are similar in another, such as two notes that are an octave apart, are identified in the space.

**Preserving the Past**  
Structures that have stood for thousands of years are now crumbling because of air pollution. Mathematicians are using models that incorporate factors such as humidity, temperature, and the level of pollution to better understand the degradation process (which occurs when pollutants reacting with water vapor transform the outer surface of stone into a vulnerable layer of porous gypsum). The models, based on differential equations, can prove to be better strategies for restoring ancient monuments, perhaps preventing their destruction.

**Solving Sudoku**  
Sudoku puzzles involve a lot of mathematics. Of course, the puzzle is filled with numbers, but the solution process would be the same regardless of the symbols used. More interesting is the logic behind the solution process, which can provide extra satisfaction upon solving a puzzle (with a bit less strategy). In addition, the puzzles are examples of Latin squares—important in abstract algebra and in statistics, in experimental design.

**Burying Carbon Dioxide**  
One possible way (along with improving energy efficiency and finding alternate fuels) to deal with the huge amount of carbon dioxide given into the atmosphere is carbon sequestration (burying CO<sub>2</sub> thousands of feet underground in old or unusable reservoirs before it can contribute to global warming). But so too is mathematics. Linear algebra, numerical analysis, and partial differential equations underlie the models that combine with small-scale experiments to predict the extent of underground leakage and help determine the feasibility of carbon sequestration.