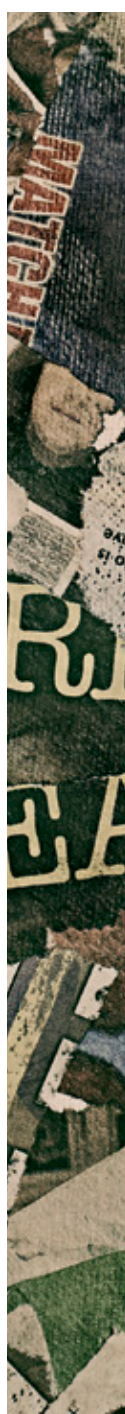


# HUMANS HAVE LANDED ON MARS

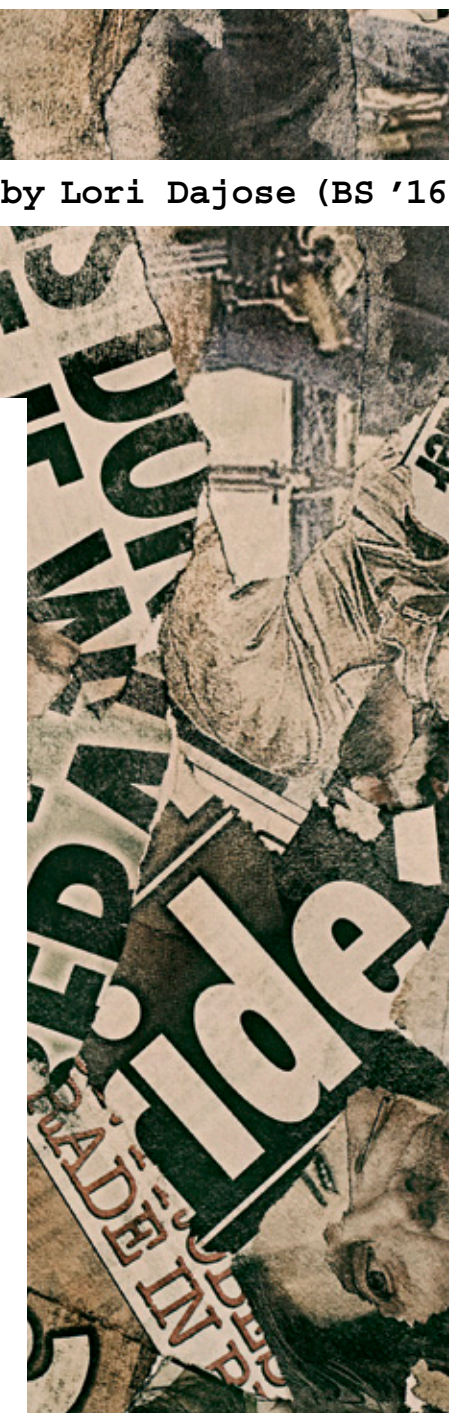
... and 10 other scientific misconceptions debunked



by Lori Dajose (BS '16)

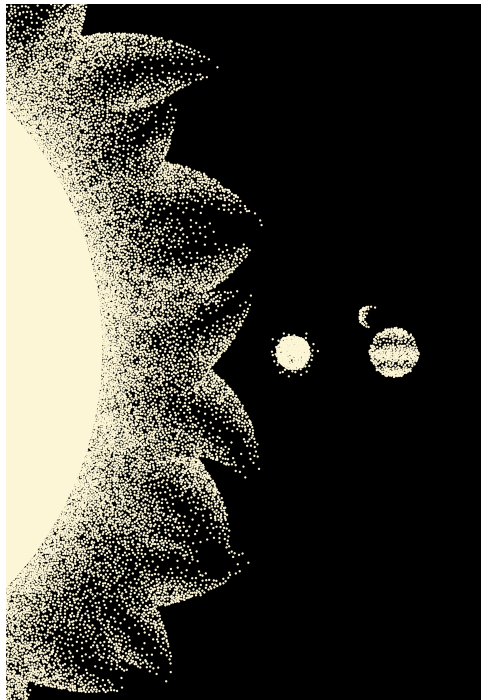
WHEN someone asks me what I majored in at Caltech, I tend to hesitate. Sometimes the answer, planetary science, draws some puzzled looks from nonscientists. If they misheard me, they might say, "I love plants, I'm actually a vegetarian!" Or, if they heard me correctly: "So, where are the aliens? Can you bring Pluto back?" And so on. Once, a person responded by telling me his favorite planet was Europa: a good effort at conversation, though Europa is not, in fact, a planet.

Misunderstandings abound when it comes to science. Here, eight Caltech scientists correct some common misconceptions people have about areas of research.



Watch Caltech scientists debunking earthquake myths at [magazine.caltech.edu/post/scientific-misconceptions](https://magazine.caltech.edu/post/scientific-misconceptions)





**Myth #1:**  
**Solar energy is cheap and clean**

"Solar cells convert the sun's energy to electricity in materials called semiconductors. Most solar cells use silicon as a semiconductor. Silicon is a good material; it's efficient, and the field is close to maximizing the material's potential. However, silicon is actually quite difficult to produce. It's expensive and uses some harsh chemicals. For solar cells to keep getting cheaper, we need to find some alternatives to silicon.

"I'm working on making solar cells out of new, ultrathin semiconductors called transition metal dichalcogenides. They can absorb the same amount of energy as a silicon cell, but because they're almost a thousand times thinner, you can make a thousand times as many cells for the same amount of material. This would make solar cells much cheaper to produce."

Cora Went, Graduate Student in Physics

**Myth #2:**  
**PEOPLE HAVE BEEN TO MARS**

"It's a pretty common misconception for people to think that we have already sent humans to Mars and that we've already brought samples back. We've done neither of these things!

"Retrieving samples from Mars is difficult because getting off Mars is difficult. A craft that lands on Mars's surface also needs to carry a rocket that can launch from there. The components of rockets don't do so well with extreme temperature changes, and on Mars you get 90-degree temperature swings in the course of an average day. Doing that over and over to your rocket is not good for reliability.

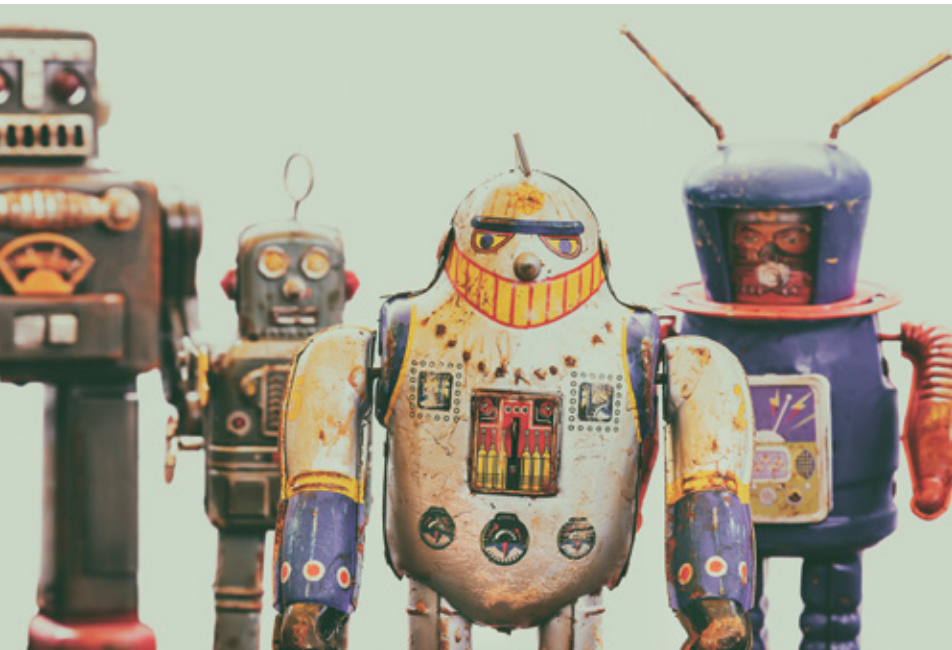
**Myth #3:**  
**Stem cell research requires embryonic tissue**

"There's a common misconception about stem-cell biology that all of the stem cells used in our research are taken from unborn embryos. In fact, you can make stem cells very easily from any type of adult tissue by just introducing a couple of transcription factors (molecules that modify gene expression). A lot of people react strongly when I say I work on stem cells because they think they come from embryos, but, in fact, I use stem cells from adult skin cells."

Alison Koontz, Graduate Student in Biology

"Putting people on Mars is hard because space is not a hospitable place for humans. A one-way trip to Mars takes seven months, and a roundtrip takes about two years because Earth's and Mars's orbits align only infrequently. So not only do you need to bring enough food, water, and fuel, you have to keep the astronauts protected from cosmic radiation and the microgravity that weakens their bones. Any spacecraft carrying humans would need to be five to 10 times more massive than the Curiosity rover, and getting that heavy a craft to land safely on Mars is a tough task we haven't solved yet."

Bethany Ehlmann, Professor of Planetary Science and JPL Research Scientist



**Myth #4:**  
**AI will lead to a robot uprising ... or solve the world's problems**

"Artificial intelligence (AI) can be heavily distorted as two extremes: the first is the idea that AI will become dystopian and destructive to humanity, and the second is the notion that AI will solve all of the world's problems by making super-intelligent scientific advances. Neither of these are true in the foreseeable future.

"Even though the field has made a lot of progress recently, the simplest of tasks (for humans) are still extremely challenging for AI to tackle. Take computer vision, for example; the process of teaching computers to recognize objects in an image. For a human, identifying discrete objects in an image is so trivial we don't even think of it as a challenging problem. Currently, there is a big difference between the mechanisms that humans use to see and the mechanisms used by computers. For example, say you add a small amount of noise to an image. A person can 'overcome' the noise and still easily perceive what is in the image. But a machine can be completely fooled. Humans have an inbuilt robustness, but artificial intelligence is more brittle.

"We do, however, need to take caution in some aspects of using AI. For example, AI can become biased and unfair toward certain demographics if it learns from biased data. What's more, launching poorly designed systems into the real world, like self-driving cars, can cause fatal accidents because they go wrong in nonintuitive ways. We don't even know when to expect systems to make mistakes because they make decisions so differently from humans."

Anima Anandkumar, Bren Professor of Computing and Mathematical Sciences

**Universal Truths**

With unfathomable distances, sizes, and incomprehensible timescales, outer space can seem abstract to people who aren't astronomers. Astronomy graduate student Mia de los Reyes explains a couple of common misconceptions about the universe:

**Myth #5:**  
**Galaxies are basically static**

"In the same way a forest seems peaceful but is constantly changing, galaxies are ecosystems that are ever-evolving. Stars are being born and dying, material is flowing around, and galaxies gravitationally interact with one another. When people think of galaxies, they think of static pictures. But galaxies are very much dynamic."



**Myth #6:**  
**There is a "center" of the universe**

"The phrase 'center of the universe' is used casually, but it's interesting because there actually is no center of the universe. Even though the universe is expanding, it's happening everywhere at the same time. Space itself is being stretched out. The expansion looks the same from any point within the universe because everything is moving away from everything else."



Myth #7:

# Genetically modified food is unsafe



"In agriculture, there are two ways to create a genetically modified organism, or GMO. The first is simply to speed up the natural process of breeding: take a gene from one plant and put it in another of the same kind, such as a tomato plant. The other way is to take a gene from one organism and put it into a different type of organism; taking the gene that produces a natural insecticide in a bacterium and transplanting it into a corn plant, for example.

"In order for any of the resulting GMOs to go to market, they first have to be tested extensively by the USDA, the FDA, and the EPA.

"There has been some lobbying to require labels to identify foods that are genetically modified. This is actually rather counter-productive because it gives the erroneous impression that one type of food is 'safer' than another. Take the natural insecticide BT, for example, isolated from a bacterium called *Bacillus thuringiensis*. Plants can still be labeled 'organic' when they are sprayed with BT. Plants like corn, cotton, and soybeans can also be genetically modified to produce this pesticide themselves, and since they produce it internally, these plants don't need such a high dose for the insecticide to be effective.

"So, in this case, the GMO plant would actually have less insecticide on it than its 'organic' counterpart. People might be afraid to purchase it, though, simply because it is labeled 'genetically modified.'"

Sarah Cohen, Graduate Student in Biology



Myth #9:

## Math is all about numbers

"Math is not really about calculations and computations. It's the study of different abstract structures and their properties.

"The fundamental pursuit of mathematics is to define a structure consisting of some objects and rules for how they can interact and then try to prove that those structures must behave in a certain way. The system doesn't have to describe the real world, and it doesn't have to use numbers. Systems of logic, not numbers, are the foundations of mathematical construction. For example, you can look at geometric shapes and surfaces, and figure out how they behave.

"Everything in math is about building something. You create something abstract and set some definitions and rules for how it works, and you play with it and see what happens. If you succeed in proving through a logical argument that your abstract system always behaves in a certain way, you also understand the behavior of all the different specific examples."

Jane Panangaden, Graduate Student in Mathematics

## Shaky Understanding

Earthquakes are scary, not only because of their potentially destructive effects but because they can happen anytime. **Staff seismologist Jen Andrews** addresses two common seismic issues:

We also forecast how the faults might interact: an 8 on the San Andreas could stress nearby faults and possibly trigger a 7 on those. But it's not prediction. We don't know when it will happen."

Myth #10:

## Science can predict when the Big One will happen

"As seismologists, we're often asked if we can predict when the Big One (a magnitude 7 or 8 earthquake, most likely on the San Andreas Fault) is going to happen. We can't actually predict when it will happen, but we do something called forecasting, which is where we give some idea of the likelihood of certain events of certain magnitudes within specific time frames. The natural cycle of the San Andreas system shows a magnitude 7 or 8 every few hundred years at different sections, and we haven't had one for 300 years in the southern section, so we estimate that there is a 19 percent chance that we will have an event greater than M6.7 within the next 30 years.

Myth #11:

## Earthquakes open up huge chasms in the ground

"Movies can scare people when they portray earthquakes as opening up massive, jagged chasms in the ground. Even though huge earthquakes release lots of energy, the ground physically doesn't move very far. The amount of slip on the fault does correlate with the magnitude of the earthquake. To create a magnitude 7.8, like the earthquake that essentially destroyed San Francisco in 1906, the ground moves on the order of meters, maybe 20 feet or so. But, how much of the fault is moving a meter matters, too. In the 6.7 Northridge quake of 1994, about 30 kilometers of fault moved 1 meter. It doesn't sound like much, but it has the potential to create enormous damage."



Myth #8:

# Voter discrimination is a thing of the past

"In 2013, the U.S. Supreme Court held in *Shelby v. Holder* that the most important provision of the Voting Rights Act was unnecessary. In his majority opinion, Chief Justice Roberts asserted that discrimination against African American voters was no longer concentrated in the South and that combating it was now less important than upholding states' rights. My research shows, however, that voting discrimination is still widespread, and that it is, in fact, still concentrated in the South.

"It's also a misconception to think that prejudiced people show prejudice to all groups equally. For example, in the mid-1850s, the Know-Nothing Party in Massachusetts was very anti-Catholic and anti-Irish, but it supported school desegregation for black and white children. Prejudice is not universal and uniform, which complicates the study of discrimination and bias.



"For those of us who study racial discrimination today, it can actually be quite difficult to determine public attitudes. Most racially prejudiced people are not going to admit in a survey that they are racially prejudiced. So, sociologists and social psychologists must devise ways to measure implicit bias in order to identify the attitudes people really hold and whether beliefs align with their behavior."

Morgan Kousser, Professor of History and Social Science