Jorge Cham's popular comic strip about the lives of hapless grad students takes him to the Large Hadron Collider—and launches a series of comics that explains the science with remarkable clarity.

Piled higher and deeper

By Kathryn Grim

During graduate school, Jorge Cham used to procrastinate by drawing cartoons for the school paper. Now he makes comics for a living, "and I procrastinate by doing research," he says.

Cham, 32, draws the online comic strip *PhD*, or *Piled Higher and Deeper: Life (or Lack Thereof) in Academia*. In his spare time, he visits research institutions for inspiration and gives lectures about the benefits of putting off work.

A couple of trips last summer took him to CERN, the world's largest particle physics laboratory, located on the Swiss-French border. There he studied high-energy physics graduate students in their natural habitat.

Cham doesn't consider himself a reporter; "I just write about what interests me," he says. But the five comic strips he drew after his visits give a clearer explanation than many articles do of the research to be conducted with the Large Hadron Collider. They illustrate the goals of the accelerator and how it works. In fact, his depiction of the LHC so impressed lab officials that they commissioned him to draw a series of CERN comics they can use for public outreach.

The comics also stand out because they illustrate grad students' ability to laugh at themselves. In the case of the LHC, Cham finds humor in preparing to do research when the thing you're most certain about is that you will find something you never expected.

Hooked on comics

Cham was born and raised in Central America, where his parents worked in the Panama Canal Zone for the US government.

He learned English in part by watching a television channel produced for North Americans working at the canal. He soaked in *The Cosby Show*, *The Brady Bunch,* and *The Flintstones*.

But sitcoms weren't the only bit of Americana Cham took to heart.

"One day my father stopped at a garage sale one of the American families was having," he says. "He picked up a box full of old comics—*Archie*, *Peanuts*. That got me and my brother into reading comics, and we never stopped."

Cham's parents held advanced degrees, and his older brother, Jaime, went to the United States for college. Eventually Cham and his younger sisters all did the same.

He followed his brother to the Georgia Institute of Technology and then Stanford University, studying engineering with the intention of becoming a professor. He took a full load of classes and knocked on professors' doors, offering to work without pay in the hope that they would like him so much they would hire him.

"It was pretty painful," Cham says. "It wasn't just the workload. It was the level at which you were expected to perform." He was at the top of his class at Georgia Tech, he says, but at Stanford he barely kept up.

He was also doing a lot of doodling.

During Cham's first term, the Stanford student newspaper ran an ad asking for student cartoonists. "I imagined they were asking undergraduates," Cham says. "But my brother said there should be a comic by a grad student—because that's when the real pain begins."

Cham agrees. "It's a story you don't hear anywhere else," he jokes—"the ignominy, the humiliation."

Nameless in academia

Piled Higher and Deeper follows the lives of several graduate students, most in scientific fields, as they navigate a world of living on Ramen noodles and coffee, teaching clueless undergraduates, and searching for thesis advisors who appear only when you don't need them.

The name of the strip came from students' interpretation of the degree titles BS (Bull…), MS (More of the Same), and PhD (Piled Higher and Deeper).

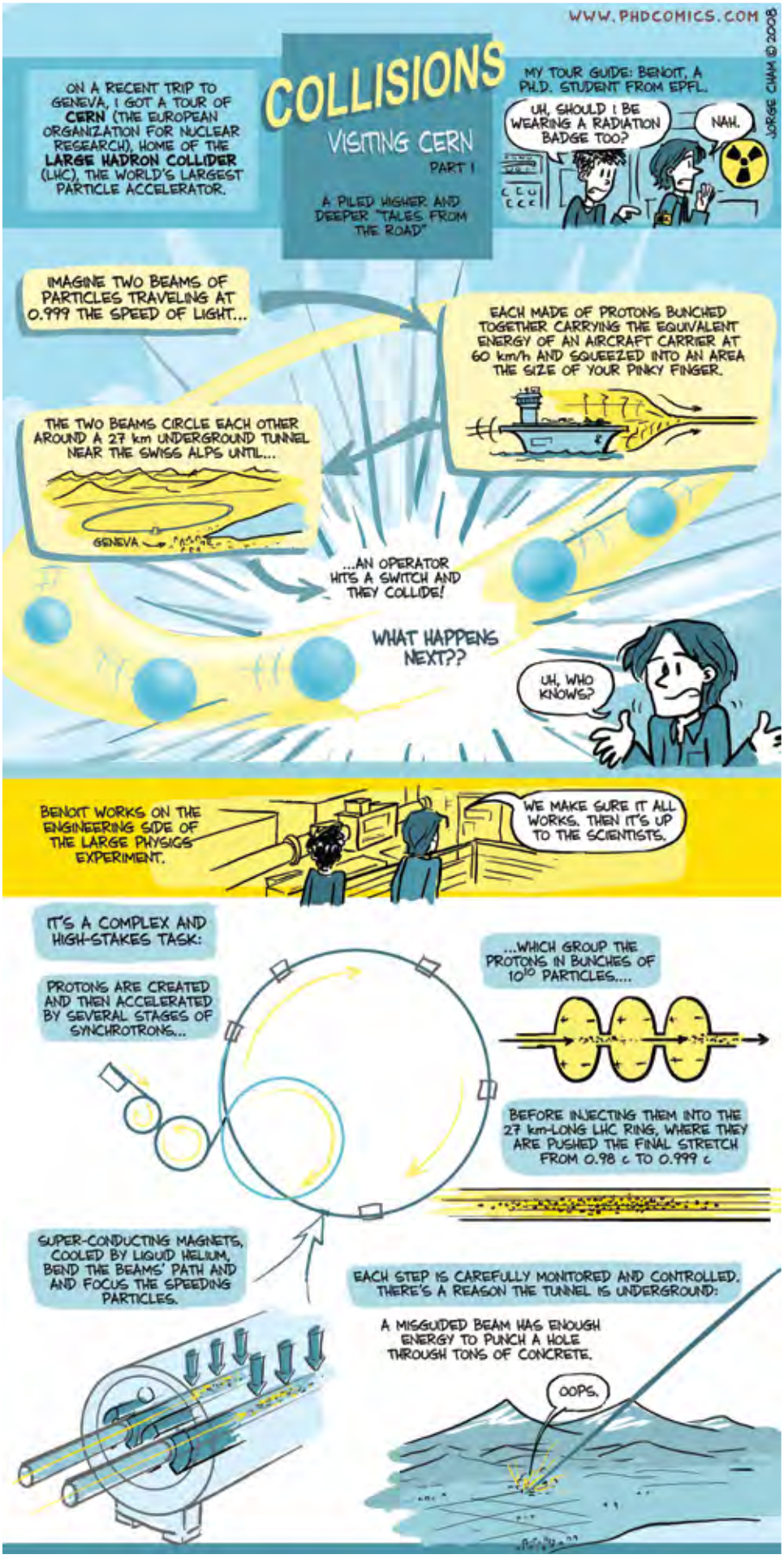
The main character, a grad student modeled after Cham, remains nameless in the strip. "When you're a graduate student, professors never remember your name, so it seemed appropriate," he says.

One of the charms of Cham's comic is that he often shows the world of research through the eyes of the underdog. He was curious about the start-up of the LHC, from the cutting-edge science down to the rumors he'd heard about the possibility that it would create a black hole and destroy the Earth. So he asked a few graduate students to give him the unofficial tour of the facility.

"I'm really always interested to talk to grad students," Cham says. "I feel like they are still at that point where they're enthusiastic and curious and aren't jaded about research. When someone becomes a professional researcher, it becomes a different thing in their head. They've had to sell their research so much at this point they automatically go into their sales pitch. Grad students are still sort of struggling to understand what they're doing, what it all means."

Cham encountered that level of self-reflection when he asked one of his tour guides at CERN why he volunteered to show him around.

"Well, it's interesting to work on this stuff," the student said, "but it's also interesting to share it."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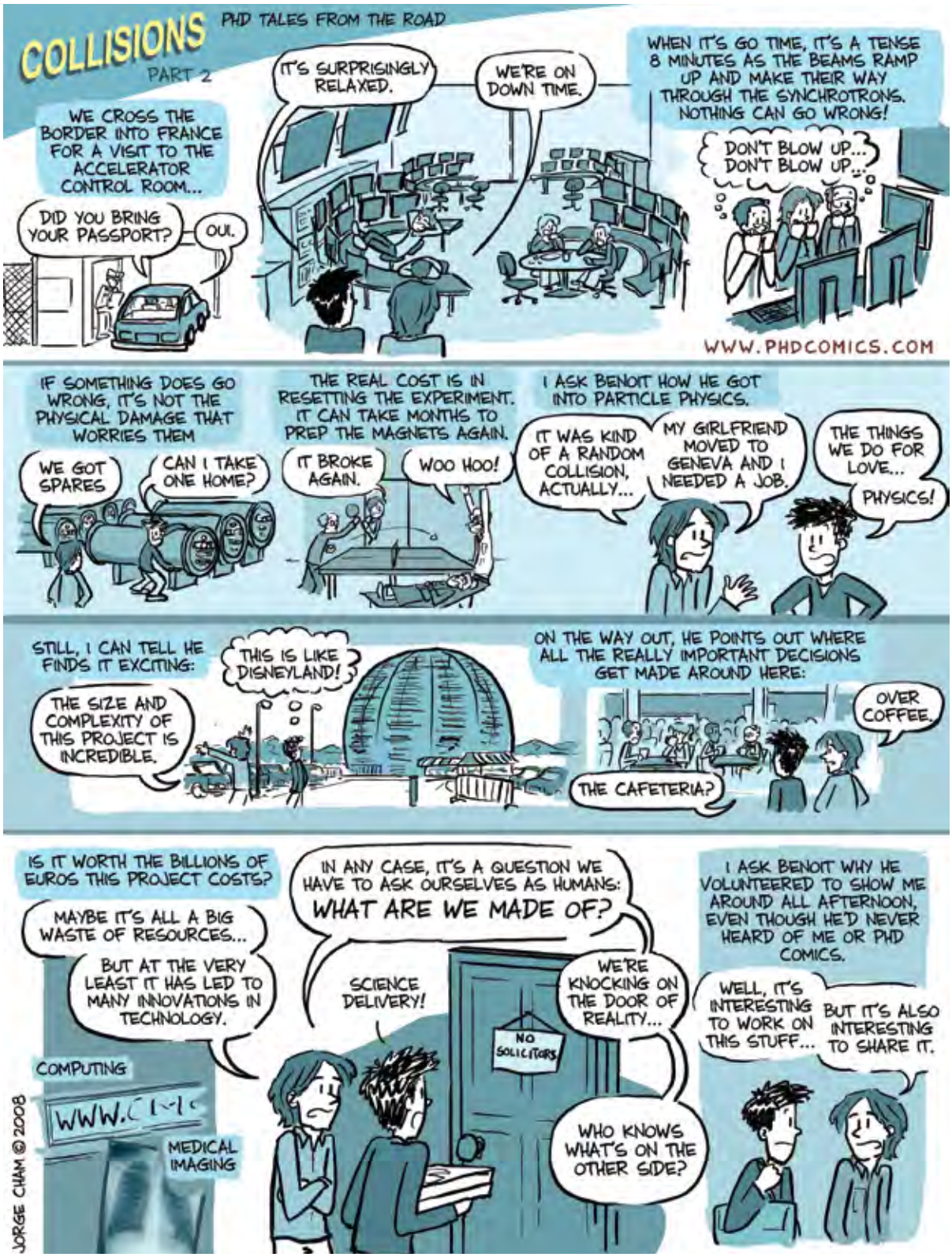
COLLISIONS
VISITING CERN
PART I
A PILED HIGHER AND DEEPER "TALES FROM THE ROAD"
JORGE CHAM © 2008
ON A RECENT TRIP TO GENEVA, I GOT A TOUR OF CERN (THE EUROPEAN ORGANIZATION FOR NUCLEAR RESEARCH), HOME OF THE LARGE HADRON COLLIDER (LHC), THE WORLD'S LARGEST PARTICLE ACCELERATOR.
MY TOUR GUIDE: BENOIT, A PH.D. STUDENT FROM EPFL.
UH, SHOULD I BE WEARING A RADIATION BADGE TOO?
NAH.
IMAGINE TWO BEAMS OF PARTICLES TRAVELING AT 0.999 THE SPEED OF LIGHT...
EACH MADE OF PROTONS BUNCHED TOGETHER CARRYING THE EQUIVALENT ENERGY OF AN AIRCRAFT CARRIER AT 60 km/h AND SQUEEZED INTO AN AREA THE SIZE OF YOUR PINKY FINGER.
THE TWO BEAMS CIRCLE EACH OTHER AROUND A 27 km UNDERGROUND TUNNEL NEAR THE SWISS ALPS UNTIL...
GENEVA
...AN OPERATOR HITS A SWITCH AND THEY COLLIDE!
WHAT HAPPENS NEXT??
UH, WHO KNOWS?
BENOIT WORKS ON THE ENGINEERING SIDE OF THE LARGE PHYSICS EXPERIMENT.
WE MAKE SURE IT ALL WORKS. THEN IT'S UP TO THE SCIENTISTS.
IT'S A COMPLEX AND HIGH-STAKES TASK:
PROTONS ARE CREATED AND THEN ACCELERATED BY SEVERAL STAGES OF SYNCHROTRONS...
...WHICH GROUP THE PROTONS IN BUNCHES OF 10^{10} PARTICLES....
BEFORE INJECTING THEM INTO THE 27 km-LONG LHC RING, WHERE THEY ARE PUSHED THE FINAL STRETCH FROM 0.98 c TO 0.999 c
SUPER-CONDUCTING MAGNETS, COOLED BY LIQUID HELIUM, BEND THE BEAMS' PATH AND AND FOCUS THE SPEEDING PARTICLES.
EACH STEP IS CAREFULLY MONITORED AND CONTROLLED. THERE'S A REASON THE TUNNEL IS UNDERGROUND:
A MISGUIDED BEAM HAS ENOUGH ENERGY TO PUNCH A HOLE THROUGH TONS OF CONCRETE.
OOPS.


COLLISIONS
PART 2
PHD TALES FROM THE ROAD
WE CROSS THE BORDER INTO FRANCE FOR A VISIT TO THE ACCELERATOR CONTROL ROOM...
DID YOU BRING YOUR PASSPORT?
OUI.
IT'S SURPRISINGLY RELAXED.
WE'RE ON DOWN TIME.
WHEN IT'S GO TIME, IT'S A TENSE 8 MINUTES AS THE BEAMS RAMP UP AND MAKE THEIR WAY THROUGH THE SYNCHROTRONS. NOTHING CAN GO WRONG!
DON'T BLOW UP... DON'T BLOW UP...
WWW.PHDCOMICS.COM
IF SOMETHING DOES GO WRONG, IT'S NOT THE PHYSICAL DAMAGE THAT WORRIES THEM
WE GOT SPARES
CAN I TAKE ONE HOME?
THE REAL COST IS IN RESETTING THE EXPERIMENT. IT CAN TAKE MONTHS TO PREP THE MAGNETS AGAIN.
IT BROKE AGAIN.
WOO HOO!
I ASK BENOIT HOW HE GOT INTO PARTICLE PHYSICS.
IT WAS KIND OF A RANDOM COLLISION, ACTUALLY...
MY GIRLFRIEND MOVED TO GENEVA AND I NEEDED A JOB.
THE THINGS WE DO FOR LOVE...
PHYSICS!
STILL, I CAN TELL HE FINDS IT EXCITING:
THIS IS LIKE DISNEYLAND!
THE SIZE AND COMPLEXITY OF THIS PROJECT IS INCREDIBLE.
ON THE WAY OUT, HE POINTS OUT WHERE ALL THE REALLY IMPORTANT DECISIONS GET MADE AROUND HERE:
OVER COFFEE.
THE CAFETERIA?
IS IT WORTH THE BILLIONS OF EUROS THIS PROJECT COSTS?
MAYBE IT'S ALL A BIG WASTE OF RESOURCES...
BUT AT THE VERY LEAST IT HAS LED TO MANY INNOVATIONS IN TECHNOLOGY.
COMPUTING
WWW.
MEDICAL IMAGING
IN ANY CASE, IT'S A QUESTION WE HAVE TO ASK OURSELVES AS HUMANS:
WHAT ARE WE MADE OF?
SCIENCE DELIVERY!
WE'RE KNOCKING ON THE DOOR OF REALITY...
NO SOLICITORS
WHO KNOWS WHAT'S ON THE OTHER SIDE?
I ASK BENOIT WHY HE VOLUNTEERED TO SHOW ME AROUND ALL AFTERNOON, EVEN THOUGH HE'D NEVER HEARD OF ME OR PHD COMICS.
WELL, IT'S INTERESTING TO WORK ON THIS STUFF...
BUT IT'S ALSO INTERESTING TO SHARE IT.
JORGE CHAM © 2008

The power of procrastination

In the early days of the Internet, Cham started putting his comic online, first as part of his personal Web site and then on a site of its own. The site gradually built a following and now has an international audience of almost 3.4 million unique visitors per year, including representatives of more than 1000 schools. Cham has sold more than 46,000 books of his comic strips.

While refining *PhD*, Cham earned his PhD in mechanical engineering and taught at the California Institute of Technology for two years. He then embarked on a new experiment: writing his comics full-time. He augments his earnings by visiting universities to give a lecture he calls "The Power of Procrastination."

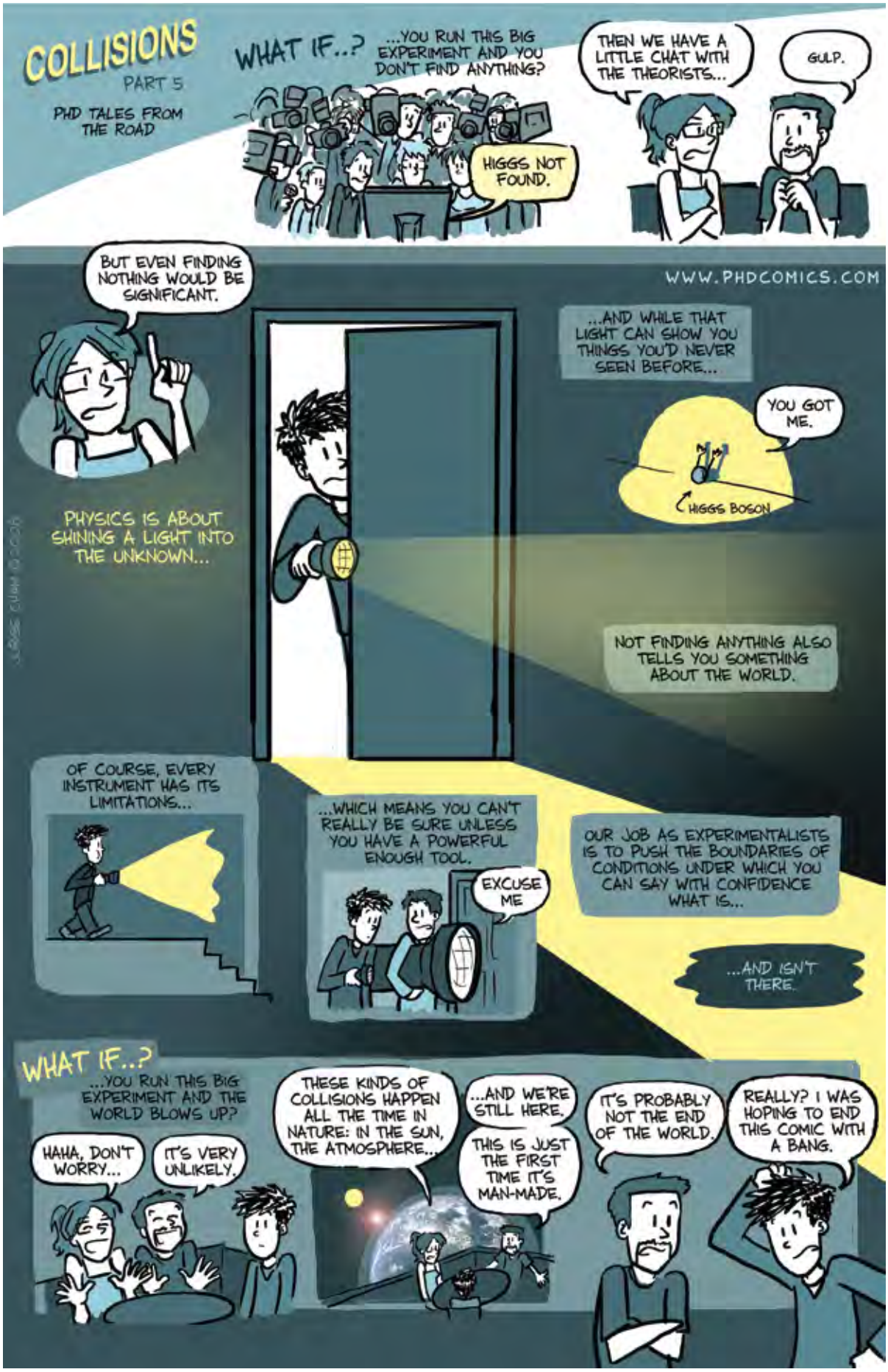
"Historically, a lot of great things have happened when people were procrastinating," Cham says. Take the story of Sir Isaac Newton, who supposedly discovered gravity when an apple fell onto his head: "The real question is," Cham says, "what was he doing under that tree?"

Cham says he hopes he can alleviate some of the guilt grad students, who so often make up the backbone of research, feel for procrastinating in academia. After all, he's made a career of it.

According to *Piled Higher and Deeper*, Newton's First Law of Graduation states that "a grad student in procrastination tends to stay in procrastination unless an external force is applied to it."

So Cham can rest assured he will always have an audience of grad students reading just one more comic, they swear, before they get back to work.


WORKING ON SUCH A HIGH-PROFILE PROJECT MUST BE REALLY EXCITING, HUH?
COLLISIONS
PART 4
PHD TALES FROM THE ROAD
MEH. THERE ARE 2000 PEOPLE IN MY GROUP.
THAT'S NOT A RESEARCH TEAM ANYMORE, THAT'S A SMALL TOWN!
THE EXCITEMENT GETS A LITTLE DILUTED.
A SMALL TOWN COMPLETE WITH ITS OWN GOSSIP, DRAMA AND POLITICS...
TERESA'S ROLE IN THIS ARMY OF SCIENTISTS IS TO STAND IN THE FRONT LINES AGAINST THE ONSLAUGHT OF DATA THAT IS GENERATED.
SURROUNDING THE COLLISION POINT IS A GIGANTIC STRUCTURE CALLED A.T.L.A.S...
...MADE OF LAYERS UPON LAYERS OF SENSORS...
WITH OVER 160 MILLION CHANNELS OF DATA...
OUTPUTTING ABOUT 1 MILLION GIGABYTES PER SECOND.
TERESA WORKS ON ONE OF THE FIRST LAYERS OF FILTERS THAT SCREEN THE DATA IN REAL TIME FOR EVENTS THAT MATCH THE THEORETICAL PREDICTIONS.
WHAT HAPPENS TO ALL THE OTHER DATA?
WE THROW IT OUT.
BEING A GOOD PHYSICIST IS KNOWING HOW TO APPROXIMATE--
YOU HAVE TO DECIDE WHAT IS IMPORTANT AND WHAT CAN BE IGNORED.
APPARENTLY, THIS IS ALSO TRUE IN THEORY:
WE THROW OUT EQUATION TERMS ALL THE TIME. IN QUANTUM PHYSICS EVERYTHING IS POSSIBLE, BUT NOT EVERYTHING IS LIKELY.
WWW.PHDCOMICS.COM
REALIZING THIS OFTEN COMES AS A DISAPPOINTMENT TO MANY PEOPLE.
SOMETIMES, OUR EXPECTATIONS OF RESEARCH AND THE REALITIES OF IT COLLIDE.
YOU GROW UP THINKING SCIENCE IS THIS PURE THING,...
YAY SCIENCE!
...BUT WHEN YOU GET INTO IT YOU FIND OUT IT'S MESSY AND FULL OF GUESSES AND APPROXIMATIONS.
$%#* SCIENCE!
WE ALL THINK OUR RESEARCH IS BULLSH*T.
IF YOUR RESEARCH IS BULLSH*T, WHAT IS MINE??
JORGE CHAM © 2008


COLLISIONS
PART 5
PHD TALES FROM THE ROAD
WHAT IF..?
...YOU RUN THIS BIG EXPERIMENT AND YOU DON'T FIND ANYTHING?
HIGGS NOT FOUND.
THEN WE HAVE A LITTLE CHAT WITH THE THEORISTS...
GULP.
WWW.PHDCOMICS.COM
BUT EVEN FINDING NOTHING WOULD BE SIGNIFICANT.
PHYSICS IS ABOUT SHINING A LIGHT INTO THE UNKNOWN...
...AND WHILE THAT LIGHT CAN SHOW YOU THINGS YOU'D NEVER SEEN BEFORE...
YOU GOT ME.
HIGGS BOSON
NOT FINDING ANYTHING ALSO TELLS YOU SOMETHING ABOUT THE WORLD.
OF COURSE, EVERY INSTRUMENT HAS ITS LIMITATIONS...
...WHICH MEANS YOU CAN'T REALLY BE SURE UNLESS YOU HAVE A POWERFUL ENOUGH TOOL.
EXCUSE ME
OUR JOB AS EXPERIMENTALISTS IS TO PUSH THE BOUNDARIES OF CONDITIONS UNDER WHICH YOU CAN SAY WITH CONFIDENCE WHAT IS...
...AND ISN'T THERE.
WHAT IF..?
...YOU RUN THIS BIG EXPERIMENT AND THE WORLD BLOWS UP?
HAHA, DON'T WORRY...
IT'S VERY UNLIKELY.
THESE KINDS OF COLLISIONS HAPPEN ALL THE TIME IN NATURE: IN THE SUN, THE ATMOSPHERE...
...AND WE'RE STILL HERE.
THIS IS JUST THE FIRST TIME IT'S MAN-MADE.
IT'S PROBABLY NOT THE END OF THE WORLD.
REALLY? I WAS HOPING TO END THIS COMIC WITH A BANG.