Student questions: Stefi Baum colloquium on "The Long Arc of Science"

4/20/16

Question 1: What makes the difference between an idea that differs from the norm and one that's just plain crazy?

Good question! Linus Pauling famously said, "If you want to have good ideas you must have many ideas. Most of them will be wrong, and what you have to learn is which ones to throw away." Frequently only time and diligence in checking the evidence against the idea, and yourself approaching the question with a critical and open mind will tell. Some normal seeming ideas turn out to be crazy and some crazy ideas turn out to be right.

Question 2: Do you have any advice for dealing with the backlash from colleagues caused by data that differs from what's expected?

One of the worst mistakes a scientist can make, in my opinion, is to throw away data that looks unusual/doesn't fit the norm, and keep the data and publish the results on the data that does. That is just bad science. So have the courage of your convictions, consider all results (those that fit and those that don't) with a wary eye and demand that they stand the test of time, careful poking at, recalibration, reassessment, etc. And remind your colleagues about the important values of science, an important one of which is to be unbiased as we assess the answers provided by the natural world. You could point them to the web pages, the video and the papers provided in my talk too!

Question 1: One of the virtues of the video you showed us was believing in your data. But sometimes your data is not accurately representing reality. How do you ensure that the anomaly that you are studying is a true discovery or a mere artifact?

The answer will present itself over time, with due diligence on your part, and an open mind. It could be a discovery or it could be an artifact, so think of tests that can rule out it being an artifact and carry them out. Be critical of your own discovery until you are convinced it is a discovery, and if you find instead that it is an artifact admit that too. No failure! No risk no reward as they say…

Question 2: It's easier to get funding and published when you are researching one of the popular scientific topics. However, it is unlikely that unpopular scientific topics are necessarily unworthy of studying. What would be a strategy for determining what topic is particularly worth researching further?

James Watson advised, "I guess I would work in a field where there's still a lot of mystery rather than trying to learn to be a scientist by filling in details." I think that's very good advice myself.

Question 1: While you emphasized not backing away from publishing controversial results when you absolutely know that you're right, how do you suggest navigating a situation where your superior insists that you're wrong or your methods of data collection are flawed, potentially ruining your career?

I guess the simple answer is get a new superior, though that isn't always so simple of course. And if you look at that link to the vindication hall of fame in my talk you wlil see many folks who found themselves in that situation, and at least for some time, their career's suffered from it. I think the first approach is to try to convince your superior that your methods aren't flawed and see if you can win him/her over. But you can always submit for publicaiton as well and see how the refereeing system feels about your work. And you can also seek out others in the field and see if you can build some momentum from others for your ideas/results. It won't be easy, but many important things aren't after all…

Question 2: How do you suggest rectifying a situation where your research may have been misinterpreted by a policy maker (a large focus of my research is climate change), which will in turn affect your funding and possibly your career?

Yeah that is a major issue I agree and that is super tough. I would sit down with that individual if I could, or his/her advisors and try to go through your work them one on one. Offer to be of help but try to explain where they may be misinterpreting your results.

Question 1: Has science always been structured like this? For example, scientists working against one another rather than with one another.

Yes, I think pretty much. Scientists are humans of course, and they are therefore both collaborative (positive interactions, helping each other, driving each other on to big results) and resentful sometimes of other's successes. And as humans of course we are naturally biased, to favor results that fit our world view and throw out results that don't. As we understand more from neuroscience about how we as humans think and understand things, we learn more about the foibles inherent in ourselves that we need to guard against. So I actually think the situation is getting better, in some ways, or could be getting better, though of course the stakes can be quite large (money, fame, etc.) and that can tip things in funny directions. As long as we are cognizant that as scientists we aren't immunized against the same non-scientific attributes we accuse others of, we will be okay.

Question 2: In your opinion, are we moving away from an era of scientists being against each other? This is a problem I've noticed as I keep getting more involved in the scientific community and it really does bother me. I don't understand why we fight with one another over certain ideas. Every idea (given that it is a sound idea) should be fairly evaluated whether it makes one uncomfortable or not!

Well I certainly agree with you. And the most important thing is to evaluate it on its merits, keep an open mind and not personally attack or try to intimidate individuals. It's not a perfect world out there, but as long as we are aware and speak up, it will get better.

Question 1: What started you're interest in the history of science and how has your interest developed?
I guess it started from a few different directions, on the one hand I am an avid reader about all fields of science in particular and so that has informed my thinking, on the other hand as a research scientist I find myself encountering these situations in my own work, and lastly, since I spent time at the State Department as a science policy fellow I got interested from the point of view of the impact on public policy.
Question 2: Who is your favorite scientist from history?
Benjamin Franklin. Just an amazing man as well as scientist.

Question 1: Is there any way to identify estabilishment bias and eliminate it in the sciences or is it tied to human nature?
Well I think you have answered your own question – clearly it is tied to human nature and the most powerful way to eliminate is to let the sunshine in so to speak and talk about it and point it out wherever and whenever you see it.
Question 2: When have you caught yourself arguing from a bias position?
That's an interesting question – my main problem is that I tend to be a contrarian by nature, so I have to be careful not to have a knee jerk reaction myself to anything that is mainstream!

Question 1: Is there any kind of study or science that is known and considered as a science enemy in the scientific community?
Well probably the most obvious example is the scientists who don't believe the models and predictions and/or measurements of global warming https://en.wikipedia.org/wiki/List_of_scientists_opposing_the_mainstream_scientific_assessment_of_global_warming. There have been folks in the medical field similarly who have argued against the mainstream say diet advice or in favour of medical marijuana and were considered rogues previously for example .
Question 2: Are there any regulations that stop scientists to study certain things or are they certified to study anything and everything in this universe?
Well there are types of tests on living beings that scientists are not allowed to carry out, consents required, etc. and they can't get access to all kinds of materials etc, if they are deemed dangerous for example. So they have to work within certain constraints, in safe conditions, in addition to which they have to be able to secure funding for their work.

Question 1: Concerning humility in new scientific ideas, do you believe it is more helpful in progressing the knowledge or hindersome in discouraging new scientists?
I think both humility and boldness are required. They are not mutually exclusive.
Question 2: As scientific knowledge continues to improve, do you think new ideas will be questioned more or less than in the past?
I think that today in the information age, with internet access that scientists can post their results and ideas widely and that this opening up of information, and moving away from tightly constrained journal reviewed (by just a few individuals) versus broadly considered information will encourage new ideas. They will be questioned and challenged but they will also be available for consideration.

Question 1: Do you think there will ever be a day when the majority of scientists are willing to at least give an unbiased look into ideas they consider “unorthodox”, before throwing the idea out altogether?
No, not really, sadly, because scientists are humans first.
Question 2: Have you heard the story of Alfred Wegener and his similar struggles to gain acceptance for his monumental observations that would later become the main factors in plate tectonics?
Absolutely. Another fantastic example!

Question 1: Doesn't accepting theories without much scrutiny make the whole process inefficient and make us pursue false goals?
No one suggested no scrutiny – I suggested scientific and not personally or close-minded scrutiny. All new ideas (and old ideas) should be subject to scrutiny, just professionally carried out and based on data and facts, not wishes and hopes and preconceieved ideas.
Question 2: Aren't scientists of all people supposed to be open to all ideas no matter how preposterous they seem? Why do many of them try to stick with the conventional knowledge?
Ah, right, because they are human and sometimes blind to that fact, they can be the worst at this bias because they don’t consider they have it, when they really do.

Question 1: Since AGN's are considered rare, why would it not have been a good idea to study them? Wouldn't it have been better because every other galaxy would be something to compare them to? Similar to Ceres, it is the oddball of the asteroid belt, which is why it is so heavily studied.
If rare, AGNs were considered interesting to study as specimens of physics say, but not as objects having a major impact on the evolution of galaxies, clusters, and the nature of the universe over all. It is true that sometimes odd things can hold important secrets, but sometimes they are also just odd.
Question 2: Do the jets from the AGN's have enough pressure and force to affect nearby galaxies and push them outwards? If so, is it measurable?
It is not thought that they do because the jets have a very small cross section and the integrated force therefore relative to the stars in a galaxy is small – they have a larger impact on the gas however, which they can entrain.

Question 1: You mentioned that people seem to have an adverse acceptance of new concepts in science. How do you propose to change this and make the science community more open to new ideas?
Just by talking about it and pointing it out to folks, particularly young scientists entering the field. The first step is to acknowledge the existence of the problem so to speak.

Question 1: Do you think that scienctific research in general has the potential to move faster if more scientists were to collaborate rather than compete?
Both collaboration and competition move science forward. As long as it is professional and science based both are good.
Question 2: Richard Feyman said "I'd rather have questions that can't be answered than answers that can't be questioned". Do you think that (very far off) in the future scientific knoweldge will be complete and we will be left only with answers that can't be questioned?
I don't, because so far nature has proven to be infinitely complex and maybe in the end it will never be fully understandable – it doesn't have to be finite or fixed….

Question 1: Considering the long history of people dismissing wild but true ideas, do you think that the modern scientific community has gotten better at acknowledging possible ground breaking work instead of accusing it of falsehoods?
No, I don't sadly.
Question 2: With scientific theories constantly changing, do you ever think we will be able to find absolute scientific truths? Or will they always be constantly replaced and discovered?
I think at least for the forseeable future it will always be replaced and discovered, as it has shown itself so far, not to be finite in any dimension.

Question 1: How do mothers in the US come into contact with so many PBDE's in comparsion with the rest of the world?
Because the US legislated that all materials in your house and all clothing on babies and children had to be flame resistant, and PBDEs are used as flame retardents on material, and they actually evaporate from those surfaces, and we breathe them in our homes (other countries did not have these requirements), and because the US has been much slower to ban PDBE use than say European countries. Sadly we did this to ourselves. PDBEs have also been used in a wide array of other products and seeped into the ecosystem therefore unfortunately and they last a very long time.
Question 2: Do you think there is still an aversion to scientific discoveries like that was in the past?
Yes, very much so.

Question 1: I didn't understand how the hot jet entrains the cool molecular gas without heating it up. Did I miss something here or wouldn't the interaction shock and heat the H2 gas?
Yes, it does entrain and shock the H2 gas, and it is the shocked gas that emits the lines that are observed.
Question 2: You mentioned that these AGN go quiecent when they have expelled the gas they feed on. Has this behavior been seen in a single quasar/AGN, and are the timelines such that we can see this over the course of months/years/decades?
Intermittent behaviour is seen in the activity in AGN, but that is not generally attributed to these kinds of major changes in fueling. That is expected to happen on appreciably longer time scales like say a million to a billion years.

Question 1: Is there another astronomy related theory that is actively being shunned by the community that you think has legs and could potentially follow the same path your radio galaxy research did?
This is a very good and interesting question! And I wish I had a good quick answer for you. I will have to think about this one… I think there are some very interesting ideas about the evolution of life that could be in this class for instance…
Question 2: Does the confirmation of the inflow-outflow/cooling-heating process with these ICM gasses answer previously unexplained ideas about galaxy formation or lifespan in these clusters?
In principle yes, but the devil is in the details and the physics is not all there by a large margin yet. One major unanswered question they can address is the nature of the galaxy luminosity function, particularly at the massive end.

Question 1: How can one be sure they are avoiding areas of interest that are "sciences that everyone already understands"?
If you can come up with a new unanswered question then you will be in a good space.

Question 1: You mentioned that you aren't fond of the term "scientific consensus." Why is this?
Because so many times in the past scientific consensus has been wrong. We are after scientific truth and that isn't the same as scientific consensus. Currently the terms are used interchangeably in many instances.
Question 2: Are PBDEs now banned in the U.S. and/or Canada?
Specific kinds of PBDEs are banned in some states in the US (e.g., Canada, Washington state, Maine) but not Federally and they are banned from import to Canada I believe (Canada does not produce them).