



## Interview with Col. Chris Hadfield

By Melissa Baluk (MB), Communications Coordinator and Jacqueline Wightman (JW), Communications Assistant

MB: As part of the communications team here at TRIUMF, it's our mission to share the story of research, innovation and discovery at our lab. We want to thank you for visiting today.

CH: Oh, it's my treat; I'm looking forward to the day.

MB: We have some questions from our staff. We only have a few minutes so let's get started... Maybe we can start with some questions about your experience in space.

**MB: What was the most unexpected thing that you encountered while on the space station?**

CH: We work really hard to expect everything. The reason being, we only get one try to do most things, because you're alone and it's a closed ship. So, if one system or one problem occurs, you may never get another chance to deal with it, and the costs are really high – it's an extremely expensive machine. The stakes are life and death, all the time.

We really hate the unexpected. We try to live our lives and train such that even though it doesn't happen, we expect that it might. I was an astronaut for 21 years and I trained for 21 years for an unbelievably long list of things that could happen that never did. So, when you ask what is the most unexpected thing that happened... everything was sort of expected!

Probably the most egregious [event] was: four days before I came home from my third space flight, the space station started spewing liquid ammonia out into the universe with a leak, and we had to respond with an emergency space walk on one day's notice to go fix that in order to save the station and everything on board. But it's not like it had never occurred to us that there was going to be a breakdown that we had to go do a spacewalk for, we had basically been preparing for that our entire professional careers. That's why I studied Russian for 20 years, so that day, working with Pawel Winogradow, I could help Pawel get one of the guys suited up to go outside. You could say it was unexpected, but really it was more like the actual manifestation of what happened as opposed to something that we never thought would happen. There's a difference.

MB: Right, being prepared for the unexpected.

CH: Yeah, spending your entire life training. So, there are thousands of things that we were immensely trained for that didn't happen. Maybe that's the unexpected part!

**MB: Thank you. So, as a nuclear and particle physics lab, we constantly monitor radiation levels and we wear dosimeters– as you'll see on your tour. Many researchers were curious to know: What was your radiation exposure for the time you spent in space?**

CH: It very much depends on the solar cycle, everyone here [at TRIUMF] knows, but the level of energy coming from the sun is on an 11 year cycle or whatever, and it's sort of like, when you have heat on your skin and your skin gets warm on its own. The world gets a little bit warmer when the sun is at its maximum cycle, and so the Earth's atmosphere expands a little; it gets a little bit bigger.

When the atmosphere is a little bit bigger, we actually have a different level of radiation and a different drag on the space ship. When the atmosphere is smaller, it's a different environment for us. That affects us, and also what's going on with the sun, like sunspots and big events pouring out of the sun.

I don't know what the actual quantification is – there are so many different units and so many different ways to measure it, as well as what is actually harmful and what isn't. We live by OSHA rules: you can't get more than a 3% increase of getting cancer based on the radiation, just like any radiation worker, within your entire astronaut career. Someone told me it was like having one low-level X-ray a day for the whole time up there, whether that's an accurate quantification or not.

I flew in space three times, spent about six months in space, but there are people who have been four times that. It also depends on age. If you're 95, the time to develop cancer before you die of other causes is almost nothing, but if you're 2, then that radiation dosage might have a high probability of giving you cancer. Flying a little later in life decreases the worry about radiation. It's a big, complex thing. In my case, it wasn't anywhere near limiting. I could easily have flown again if the only variable was radiation dosage.

MB: Great. We have trouble [with radiation exposure quantification] too sometimes; we have to put it in the scale of bananas or something so that people understand. It's a big topic.

CH: Well, just to be specific, the premenopausal female astronauts, because their reproductive systems are the most susceptible to cancers as a result of ionizing radiation, are the ones who have the most restrictive rules on them flying in space. They stand the highest risk of reaching their 3% limit as a result of space flight.

**JW: Interesting. It's been about 40 years since humans travelled beyond low earth orbit. Do you think we should fly to the Moon again before trying to reach**

## **Mars? Or, do you think another different type of space mission should take priority?**

CH: The pattern of exploration is ancient; it's fundamental. We live somewhere for a while, and then, for whatever reason, some of us get dissatisfied with living there. You know? Whether it's your 17-year-old son or daughter, or whatever, someone says, "you know, I think we should live over there!" And so, they send out a probe.

Fifty thousand years ago your probe would be your oldest child. You'd say, "Go walk three days that way, look and come back and tell us if there's a place to move, because this village is getting too crowded, or we've eaten all the apples, or whatever." So they send out a probe to have a look, who comes back and goes "no, that's a terrible place, the oasis is polluted" or "yes, that's great, a lush valley, let's go there." After the probe has found a new place, and it looks to be a place that is desirable for habitation, then we start moving there.

All we've really done in space exploration has been the probing phase for the last, well since the early 60's (Sputnik was '57). Even human trips to the Moon - 12 guys walked on the moon - that was just sending a probe, that was just sending someone to go look. In November of 2000, we started moving to space. That's when we started permanently living on the space station. That was not just one country proving its point, but the whole world. We left the Earth in 2000. Almost 14 and half years ago, we left the planet and that's our first move away from home.

So, where do we go next? It's *obvious* we should go to the moon next. It's idiotic to think anything else. The moon is only three days away. We have an *enormous* number of things we have to learn and prove in order to keep the level of safety anywhere near accessible, and we know very little about the Moon. And we sure don't know much about living on another planet.

If you decided, "well, let's just skip the Moon and go to Mars!" because it sounds sort of somehow weird and romantic and exciting, you're all going to die, because we don't know what we're doing and we don't know what we don't know.

The worst part is, as soon as you've fired your engines enough to go to Mars, you can't turn around. The only way to come back is to go six or seven months all the way to Mars, sling around Mars to use its gravity to turn you around, because you have to take that 12km/s and turn it 180 degrees, because you don't have that much fuel on board. As soon as you fire your engines, you are committed to basically two years in space. So if you got anything wrong, everybody's dead. It doesn't make any sense at all.

There's no big rush, right? We're messing some stuff up here [on Earth], definitely, we need to work on our own problems, but the Earth is not poisonous to us. If the Earth somehow was poisonous to us, like if we knew that a huge asteroid was going to hit or the Yellowstone Caldera suddenly started exploding and most of the world became

uninhabitable, then we'd have some urgency, we'd be willing to take a higher risk. Mars is more habitable than the Moon. But there's no great urgency. We will go from the Space Station to the Moon, we'll eventually live on the Moon and, I think during your lifetimes, just like in Antarctica, we'll have permanent habitation sites on the Moon. Then after that, we'll have invented enough stuff, figured it out, we'll have come up with new engines, and we'll go to Mars. There's a lot of popular media stuff right now about Mars. But it's all just media stuff; it's not based in reality.

**JW: So I guess that answers the next question about whether or not you would go to Mars if you had the chance.**

CH: That's a little bit of a specious question, because of course I would! But my immediate question is: in what? Astronauts don't go for rides. I helped design the cockpit of the space shuttle in the '90's. I helped change procedures in the Russian Soyuz even after it had flown many times. We help design spaceships. We definitely design missions. We are absolutely, integrally involved in making space flight possible. We don't just take a few classes and get on a space ship and go, "Hey, tell me when we're there!" That's not how it works.

It's easy to say "Oh yeah, I'd love to go to Mars!" but the real question is "in what?" And how does the close-up environmental system work? How does your radiation protection work? How do we navigate? And – a million things! And that's the actual quest.

I would love to be involved in how to safely go to Mars. A lot of the work I did was to help set up that. But there's nobody going to Mars, not for a long time.

**JW: In training to become an astronaut you had to learn many different topics and gain many skills, so we were wondering, what topic do you wish you knew more about?**

CH: Human nature. I think. It's the most complex thing. On board the spaceship, we had people from different languages and cultures and religions and backgrounds and a fundamental primal difference in a sense of normal, just because of how they were raised and taught. With the human genome, we're discovering there are some fundamental programming differences in us depending on where we're from. If you look at the scale of autism, there are huge ranges of what's normal for people.

All of that becomes magnified in its importance when there are six of you separated from the other seven billion. How to properly take care of people is one of the big problems we need to solve as we do these long duration exploration missions as well, because we need such a skilled crew. You can't run it like a lot of sailing ships of the past, with an absolutely brutal chain of command, where you could kill parts of your crew if they were misbehaving, with just a super strict iron hand. That won't work for a spaceship.

How do you build and blend and then maintain the psychological health of a small group of people in extremely difficult circumstances that are separated [from civilization] for a long time? It's something I've studied and worked on for a long time.

The machinery is complicated, but it's way simpler than the people. I think that's the part that demands the most attention.... And particle physics.

MB: You'll get that here!

**MB: While you were up in space, you were quite famous for taking these beautiful photos and sharing them on twitter, so what advice do you have for scientists who want to use social media as an outreach tool, especially when they are busy with a space mission or a PhD thesis?**

CH: Social media is an immensely powerful communications tool that we don't understand yet, because it's so new. It's only less than a decade old. Even the Internet is only 20 years old of common widespread utility, so short. To me, social media and Internet connectivity is as significant an invention as the Gutenberg printing press, or the telephone. It's that significant an invention.

By 2020, 5 years from now, I've heard fairly credible predictions that 80% of the world will be holding a smart phone in their hand within 5 years. 80 percent. 8 out of every 10 people will have a smart phone in their hand, and the question is, what's it connected to? In space exploration right now, both Elon Musk with SpaceX and Richard Branson with Virgin Galactic are trying to come up with technologies that will drop the cost of launch by 2 orders of magnitude – by a hundred times cheaper. If they can do that, we can put cheap little throwaway communications satellites in low earth orbit, a constellation of them, so that anybody in the world who is holding one of these smart phones, instead of having to rely on their local power source or oppressive government, or Wi-Fi or whatever, can talk to anybody in the world. That is huge.

So, how do we use that tool? A lot of folks don't understand it. Most big organizations do a terrible job. They treat it like media; they don't treat it like social. Social media is an unprecedented way to share the experience of being human with anybody else who wants to share it with you. That's what it is. It's not a place to plot graphs, or to say "Check out\_\_\_!" Every time I read something that starts with the words "Check out\_\_\_!" I don't, because obviously it's just someone blaring through a megaphone.

Instead, if something delights you, or makes you laugh, or makes you cry, or surprises you, or is beautiful, or is ugly, share it. And everybody does. You'll probably go home tonight, and if something really funny or odd or human happened today, you might mention it to somebody. Or you might mention it to somebody at lunch. But, you *can* mention it to the whole world. And then the world has the choice of participating or not. That's what social media is the best at. It's especially prevalent for people that are

on the edge of exploration, whether it's an astronaut or a deep-sea diver, or a physicist, because they are right on the edge of human understanding.

If it's cute and funny and interesting and sad, and it brings out an emotional reaction in you, then it will in other people, so say why. Or show what it was, and post it so that it catches your attention, so [your post] it's a picture that you weren't expecting, and then a comment that makes you think about the picture, so that you bounce back and forth at least three times. So that you go from the idea, to the image, to the idea, and then it makes you look off into the distance and go, "huh." *That's* what you're trying to share with the world. It [social media] becomes so inclusionary, and then it's like this enormous hive of intelligence where you don't have to learn everything on your own in a dark room, but you can piggyback on other people's knowledge. It's hugely powerful.