AstronomyCast Episode 242 for Monday, December 5, 2011: The Torino Scale

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Fraser: Welcome to AstronomyCast, our weekly facts-based journey through the Cosmos, where we help you understand not only what we know, but *how* we know what we know. My name is Fraser Cain; I'm the publisher of Universe Today, and with me is Dr. Pamela Gay, a professor at Southern Illinois University – Edwardsville. Hi, Pamela. How are you doing?

Pamela: I'm doing well. How are you doing, Fraser?

Fraser: Good! So once again, we're recording AstronomyCast live as a Google plus hang-out, but we've muted them all so you can't hear any voices. Everyone's going to wave in silence. So if you want to join us for future recordings of AstronomyCast, all you have to do is join Google plus and then circle me or Pamela, and then when the hang-out is kind of approaching, we will…

Pamela: …warn you!

Fraser: …mention it, warn you, and then we'll start the hang-out up, and it's kind of a race to get in, but it's super-fun, and then we try to leave the hang-out open for another half hour, forty-five minutes after we do the recording, and we answer questions and yak about space and astronomy and photography, dogs…

Pamela: Stuff.

Fraser: Yeah, so it's awesome and super-fun, and we'd love to have you guys join us. So when you hear of a looming asteroid strike, do you wonder what to do? Should you go into your underground bunker, evacuate the state, or leave the planet? Fortunately, astronomers have developed the Torino Scale, a handy measurement that incorporates both the likelihood of a strike, and the amount of devastation. This is good; this was needed for a long time, you know? The Torino Scale?

Pamela: Well, I'm not sure it's needed so much as it's just one of those things of die/not gonna die, and probabilities.

Fraser: I mean, that was my intro, right? Asteroid YU 2005 is going to strike the Earth, you know? I gotta know! Should I evacuate Europe? Should I leave the planet? Or is it sort of no big deal, I'm just going to get out my binoculars and watch it strike the neighboring city, so um, you know? So, I think, now we've really got a really precise way to be prepared. So where did this concept come from?

Pamela: Well, back in the 1950s, as we started to realize more and more and more that our planet is kind of covered in asteroid impacts, people started thinking, well, so what do all of these different types of impacts mean?" And, well, any time you get scientists thinking hard about something, they're going to end up coming up with a numerical way of quantifying all of it.

Fraser: Right, like the Richter Scale…

Pamela: Right.

Fraser: Oh man, what is it? The Fuji…F-Scale for tornadoes? The scale for hurricanes…

Pamela: Right, so we have all these different scales, and it was finally professor Richard P. Binzel, who (he was working at MIT at the time)…it was only in 1995 that he presented this at a conference, and so this is a fairly new way of looking at the Universe and saying this is numerically quantified how it's going to destroy us, and he gave his presentation, actually at a UN-hosted conference, where they were discussing future destruction of the planet Earth.

Fraser: Right, right I, again, you can just imagine scientists going, "Is there some way we can put a number to this?" You know? So right, OK, so he presented, he sat down and decided he was going to be the one to come up with a name, but it doesn't have his name.

Pamela: No, that's actually one of the things about it that, to me, was kind of confusing until I realized it ended up getting revised in June 1999 in the Italian city of Turin, which if we weren't Americans, we would call the city of Torino. So it's named after the city where the current version of it, more or less – it got revised again later to make it more press-friendly, but it got named after the city where the current, all-but-final version of it was invented.

Fraser: Right and that sounds like a nice, sort of, way to sort of cap it off, and then we've got this nice measurement scale from this point on, and it's actually taken off pretty well, I mean, I can…that's in my time. When I started *Universe Today* back in '99, I can kind of remember when they started to incorporate that scale, and we've been watching it ever since. And now, every asteroid that has any kind of likelihood of hitting the Earth gets, you know, will get a measurement on the Torino Scale.

Pamela: And what's interesting is *you might* be one of the reasons why in 2005 they felt the need to re-change some of the wording. So this is a scale that goes…

Fraser: Me? What?! What?!

Pamela: Well, it's a scale that goes from 0 to 10, and it used to be that objects that were Torino level one, which the official definition is "a routine discovery in which a pass near

the Earth is predicted that poses no unusual level of danger." It goes on a little bit longer than that…

Fraser: We're going to go through the scale in a second, but yeah.

Pamela: So, this is now called "normal," so anything Torino level one is "normal." Well, it used to be that it was "events meriting careful monitoring," and so many members of the press went a little nuts -- not saying you'd go nuts, but you'd probably mention it anytime something got a Torino level of one, that they're like, "OK we've got to rename this so people don't panic." So in 2001, it went from "merits careful monitoring" to "normal."

Fraser: Well, and the thing is if you go through enough of these, you see the way it always plays out, which is that somebody discovers an asteroid, they quickly assign a Torino Scale to it, and then, you know, and then everybody points their telescopes at it and gets careful data on it, and then, always, every time so far, the Torino…it just drops back off the Torino Scale because they now know that it's not going to be any kind of risk, but there's this gap where the press goes bonkers, and people freak out.

Pamela: Well, it's fun!

Fraser: It's fun?

Pamela: Well, I…think about it. We live in a world where people celebrate death and destruction, and pepper spraying, and all these other crazy things that make it into the news. If it bleeds, it leads, and destroying of the planet counts as bleeding.

Fraser: Right, it is big news. Although people gotten a lot more used to it, I'm still waiting for people to get numb to asteroid discoveries and asteroid risks, and they still don't. I mean every one of them – we had a huge boost when, what was it? 2005? huge boost of traffic to the *Universe Today* because everyone was searching for it. OK, so then what is the purpose, like, what does the Torino Scale measure?

Pamela: It's sort of the planetary risk level for asteroids the way we have a color system to describe nuclear threats, the way we have a color scale to describe airport safety threats, it's just another one of these three-minutes-before-midnight threat assessments, so if it's zero, we're good. It's going past the Earth, we're fine, just smile and watch -- and ten is we all die.

Fraser: We all die. Right, but the point is when you think about the Fujita Scale (thank you to the people in the hang-out who reminded me of the name), but when you think of the Fujita Tornado Damage Scale, you have like speed of winds, and the size of the tornado itself. When you're thinking about the scale for the hurricanes, you've got, sort of, the speed of the winds, and that's just it, right? When you've got the Richter scale, we've got the amount of shaking, so what are we measuring with the Torino Scale?

Pamela: ½MV squared.

Fraser: Right, ½MV…right! So we're measuring the momentum of it?

Pamela: Well, no, no, no -- momentum is mass times velocity. This is energy.

Fraser: Right, total energy.

Pamela: So, we have to worry about what's its mass, what's its velocity as it's coming towards us, and it also has to deal with, in addition to these measurable things, it also has to deal with how likely is it that those measurable things are going to impact their energy, well, on our heads.

Fraser: So Jupiter is going to have a lot of mass and velocity, but it isn't going to hit us.

Pamela: And at the end of its day, its velocity really isn't that bad, so… It just has a giant mass that isn't going to hit us.

Fraser: Right, right. It isn't going to hit us, and the trick is if they hit us. So, it's both the velocity and the mass of the object, but also that probability of whether it's going to hit.

Pamela: So, we have things that have high probability, low mass, low velocity, do zero damage; things with high mass, high velocity that are somewhere else in the Solar System and aren't going to hit us and thus do no damage, but it's the things in between with a moderate probability of hitting us, and enough mass and velocity to make it through our atmosphere -- those are the interesting things that we like to look at.

Fraser: Right, and I know that the danger on the Torino Scale -- it could be a high probability, but not a lot of damage, and it could be the other way – a lot of damage, but a low probability of hitting us, and the Torino Scale nicely accounts for both of those.

Pamela: Right, and the thing that anyone that's gone out and has looked up for any period of time has realized is we're constantly getting hit with stuff, but the catch is we're constantly getting hit with stuff that's of a size that doesn't matter, so about every 30 seconds a 1 millimeter object hits our atmosphere – shooting star – little, tiny, probably-not-noticed shooting star. About once a year, an object one meter in diameter hits us, burns up, does no damage, and we notice over and over and over in the satellites that are looking for things being blown up -- nuclear assessment and things like that -- there are dozens to hundreds, depending on how much energy you're looking at, massive explosions in our atmosphere, Hiroshima-sized explosions in our atmosphere from things that hit us on a regular basis that no one notices because it's out over the ocean, or over the prairie or something.

Fraser: So, let's go through the Torino Scale. Let's start with the bottom, I guess, zero and walk our way up to ten.

Pamela: OK.

Fraser: So what is zero on the Torino Scale?

Pamela: Uh, nice lightshow, maybe -- probably not. This is the YU 55, so things that go past that we know exist, they're not coming anywhere near us, but we can look at them as they go by.

Fraser: So we are certain that they will not do anything to the planet.

Pamela: We are absolutely, positively certain they will do nothing to the planet.

Fraser: OK, so what is a "one" on the Torino Scale?

Pamela: A one is "the chance of collision is extremely unlikely," about the same as a random object of the same size striking the Earth within the next few decades.

Fraser: In other words, objects are randomly hitting our…what? hitting our atmosphere every few decades anyway, and so there's just neither much risk, nor much damage if it does.

Pamela: It actually kind of boils down to, "we don't know much about this object yet. It's as likely to hit us as anything else, and anything else is probably not going to hit us."

Fraser: Right. OK. Let's move on, I want to hear the next one.

Pamela: OK, so this is number two: "events meriting concern," yellow zone number two. Number two just says "a somewhat close, unusual encounter, collision is very unlikely."

Fraser: OK. Three?

Pamela: "A close encounter with a 1% or greater chance of collision capable of causing localized destruction." This is your neighbor's house is destroyed.

Fraser: Well, it's more than that, right? It's like a city.

Pamela: Yeah, but it's still confined to a region. So we've experienced these things in human memory, so it's…

Fraser: Would that be like Tunguska?

Pamela: Well, Tunguska, yes. It would also be back in 1490, there was a Chinese village that reportedly had about 10,000 people killed.

Fraser: Right, OK. Yeah, and I know we have lots of these iron meteorites that are found in, like, what is it? Campo del Cielo meteorite? And there's…so like Tunguska. for example. was like a…what? 1908 asteroid, comet, UFO traveling through a wormhole, um…

Pamela: [laughing] Something blew up in the atmosphere and flattened part of Siberia.

Fraser: Right, so in other words, it didn't cause any damage to Paris or Moscow, but it sure ruined a chunk of the Siberian forest.

Pamela: Right.

Fraser: OK. Alright, so, that is localized damage. Let's keep going.

Pamela: OK, so now we move out of yellow into threat level orange, and these are threatening events. And I just sound far too mirthful reading these, but destruction is fun! So number five is "a close encounter with a significant threat of a collision capable of causing regional devastation."

Fraser: Regional…so when they say regional, are they talking about, like, Europe? Great Britain?

Pamela: Yeah, pretty much.

Fraser: Yeah, OK.

Pamela: Let's just, like, get rid of Australia.

Fraser: So, in other words, if that happens, and great, it hits Australia, then you and me over here in North America would probably be alright.

Pamela: Right, so here we're not talking enough material getting thrown into the atmosphere that it causes global cooling. We're not…we have to worry about things like massive fires being caused, but as long as that doesn't happen, we're probably good. As long as it's elsewhere…

Fraser: And that's only half way up the scale.

Pamela: It's only half way up the scale, but these are still *probable* things, so there's a significant threat, but not a *certain* threat.

Fraser: Right. OK, keep going up.

Pamela: So threat level six is "a close encounter with a significant threat of a collision capable of causing global catastrophe," so this is the dinosaurs dying -- perhaps.

Fraser: Right, but I think the key there, and this is really weird, right? Because this is essentially complete destruction of the Earth, of all life on Earth, but we're still…but *maybe*, right? That's the trick.

Pamela: It's the *maybe* that's important. It's the *maybe* that keeps it from being a red.

Fraser: So maybe the whole Earth will be destroyed, but maybe not. Who can say? Right. OK. Let's keep going.

Pamela: OK, so threat level seven is "a close encounter with an extremely significant object capable of a collision causing a global catastrophe."

Fraser: That's seven?

Pamela: That's seven.

Fraser: Well, hold on a second, so that is again global catastrophe, and a very high likelihood of a collision?

Pamela: So we went from "significant threat" at six to "extremely significant threat" at seven.

Fraser: Are we going to be destroying the Universe by the end of this scale?

Pamela: We're just increasing certainty as we go.

Fraser: OK. Alright, it's just hard to say with these words, you just want, like, is it a 75% chance? Is it a 33% chance?

Pamela: Yeah, they don't do that for us.

Fraser: OK, let's go on to level eight. I'm scared now.

Pamela: OK, so we're now going into threat level red. These are certain collisions.

Fraser: Aaah…certain. 100% chance, yeah… There's a 100% chance that an asteroid is going to strike. OK.

Pamela: So at threat level eight, we have "a collision capable of causing localized destruction. Such events occur somewhere on Earth between once per 50 years, and once per 1000 years."

Fraser: So, this would be astronomers detecting a Tunguska-level event, or maybe meteor crater in Arizona, right? And saying…Barringer Crater? Yeah.

Pamela: Beringer.

Fraser: Yeah, Barringer, and saying, "We are absolutely going to get hit by a Barringer. It's probably going to hit, you know, Paris. Everybody ought to move away from Paris."

Pamela: See, I'm not actually sure if Barringer is localized or regional because of all of the stuff it tossed into the atmosphere.

Fraser: Right, right, you know maybe that's just… Yeah, but what is it? A Tunguska happens every 100-1000 years, so it sounds like that's sort of in the scale.

Pamela: It's definitely Tunguska.

Fraser: Well, I mean Tunguska flattened a forest for 1000s of kilometers, right? …square kilometers, so it was a pretty big event.

Pamela: Yeah, it was kind of awesome.

Fraser: …dig out a big crater, but that's kind of what we're talking about. I can see maybe Barringer being even worse, but the point being…but it's interesting, you know, the previous level was, you know, "the Earth is completely toast probably," and now we're back to "a very small part of the Earth is toast for certain." OK.

Pamela: Yes. OK, so threat level nine is "a collision capable of causing regional devastation. Such events occur between once per 1000 years and once per 100,000 years."

Fraser: Ouch. OK.

Pamela: So this is, "We see it coming. Everyone get on a plane and go somewhere else now, please. That part of the planet is about to end."

Fraser: OK, and number ten…

Pamela: Number ten: "a collision capable of causing a global climatic catastrophe. Such events occur once per 100,000 years or less."

Fraser: 100,000 years or less?!

Pamela: Yes.

Fraser: So we're not even talking about like a KT, you know the one that ruined the dinosaurs 65 million years ago; we're talking about something much less damaging.

Pamela: Well, so this is where you end up with people arguing over what counts as global catastrophe. So, does it count if it changes the weather patterns? Does it count if

you have mass extinctions? because we certainly haven't had a mass extinction in a while. So, people do squabble over those kinds of things.

Fraser: But we are talking about the end of civilization as we know it.

Pamela: Yes.

Fraser: No matter where you live, civilization is going to come to an end.

Pamela: Yes.

Fraser: Wow! So since the Torino Scale has been developed, how bad has it gotten?

Pamela: Well, we made it up to four once, briefly, but the nice thing about the scale is it's self-correcting as you get more data because up until you get into that red zone, all you're really talking about is things that *might* hit the Earth, and how bad it'll be if they happen to get to "might," or happen to get past "might." So Apophis, which we've all heard about in the news, is the big one that everyone freaks out about, and we now know it is a zero. There is no chance that we know of that on its next pass past the Earth -- and this is all we're worrying about is the scale's looking ten years out into the future. It's not going to hit us then.

Fraser: Although, there's a possibility of that in 2029, and a completely unknown possibility in 2036.

Pamela: Yeah, so it currently still has, for the 2036 encounter, a rating of a level one because we need to wait and see what happens in 2029 because its orbit will get changed as it goes past the Earth.

Fraser: So the highest…so Apophis, you know, rose in the charts to four.

Pamela: Yes.

Fraser: Which I think they kind of regretted doing that, but...

Pamela: Yeah, well, it was an honest…you see, the problem is that science is something where we're constantly learning new things, and... It was an honest level four..

Fraser: Yeah. There was enough uncertainty…

Pamela: There was an object in 2006 that temporarily got a level of two, but it got downgraded quickly, so in general, things don't make it very high on this scale.

Fraser: And they don't last long on the scale.

Pamela: Right, and what's kind of amazing is we have all sorts of surveys that are essentially accelerating the rate at which we discover asteroids, so even as we're discovering more and more and more and more asteroids on a regular basis, we're not discovering more Earth-destroyers as we go.

Fraser: Right, and in fact, I think, you know, we mentioned this in another show, we're finding all of big nasties, and have really ruled out a lot of impacts in the foreseeable future.

Pamela: Right.

Fraser: The size of asteroids is the problem that we're looking for now, and they're getting smaller and smaller, which is kind of a relief.

Pamela: And the thing interested me, in researching the show, I went through and I looked up historical accounts of people getting clobbered because you've probably seen on TV if you've ever watched any of the bad science channel specials, the story of the car that got hit, the story of the lady that had one come through her roof, and bounce off her radio and hit her…

Fraser: The dog that got killed...

Pamela: …the dog that got killed, so there's all these stories that are always in the news. But the thing that got me that I didn't know about is there's a number of different (number being 3), number of different areas getting walloped by basically a rain of solar system gravel, and so there's this story in 1490 that people argue over how accurate the numbers are, but according to the histories, the Chinese province, that I'm about to mispronounce, Chíing-yang, was hit by a whole bunch of asteroid fragments that killed about 10,000 people, and that's kind of dramatic. And there was a village in Africa that had a rain of fragments, and there's just all these stories of places basically getting rained on with shards that damage roofs -- it's like a massive hail storm, usually, but that seems to be the more frequent way of individuals having close encounters with asteroids.

Fraser: And so just as we're recording the show right now, how many objects are on the scale?

Pamela: Well, everything's on the scale…

Fraser: Oh, sorry.

Pamela: …because everything gets a Torino level.

Fraser: Sure. How many are above one?

Pamela: Well, we have nothing above one.

Fraser: Wow.

Pamela: So there are two objects that we don't know their orbits well enough to give them a zero, so there's two things that we're still following up on that have a rating of one in the near future. So, we're doing pretty good. With everything we've discovered, we are safe for at least ten years, and for the things that we know, with the exception of Apophis, there's nothing to worry about.

Fraser: Alright. Wait a minute – that was like a nice, pleasant, happy ending to that.

Pamela: That's why it allows me to giggle while reading the scale.

That Fraser: That was good. I like you reading the scale. People should…we should have a separate recording of that and then we could just listen to that show – you doing the Torino Scale. Right? Well, that was great. Well, thanks a lot, Pamela.

Pamela: It was my pleasure.

Fraser: And next week, I think, we're going to actually specifically talk about Tunguska.

Pamela: Yes.

Fraser: And that will be kind of cool. And that was from a listener who suggested that idea for a topic, so we will…we live only to serve, and we will do that episode next, so....

Pamela: And one side comment before we take off: we are recording this as we enter the Holiday season in 2011, and we just posted a bunch of new stuff in our store, including a new t-shirt design for the Venus transit next year.

Fraser: Cool!

Pamela: So if you're gearing up in your preparations for the Venus transit, and you want a map on a shirt of where the transit is visible, we have that shirt for you. So, go to Astrogear.org and get stuff for the Holidays for the people in your life, and for yourself while you're there.

Fraser: Sounds good. Alright, well, thanks a lot, Pamela.

Pamela: Sounds great!