WEBVTT

1
00:00:01.770 --> 00:00:02.700
Morgan Elowe MacLeod: There we go sorry.

2
00:00:03.090 --> 00:00:04.110
Morgan Elowe MacLeod: thanks for your patience.

3
00:00:05.490 --> 00:00:07.830
Morgan Elowe MacLeod: Well, thank you and we're really delighted to have both of you.

4
00:00:09.929 --> 00:00:10.830
Morgan Elowe MacLeod: Great to be here.

5
00:00:11.759 --> 00:00:12.900
Keivan Stassun: You ready for us to go.

6
00:00:14.880 --> 00:00:15.269
Keivan Stassun: Okay.

7
00:00:16.289 --> 00:00:20.190
Keivan Stassun: Good morning, everyone i'm caitlin Stassen and and joined by Marina kunkel.

8
00:00:21.480 --> 00:00:33.120
Keivan Stassun: We going to do a tag team presentation here talking about ways in which the the the advent of large amounts of.

9
00:00:33.600 --> 00:00:46.380
Keivan Stassun: Ultra precise light curves spectra and parallax is for stars in the Milky Way is opening this new era of of understanding, not only of.

10
00:00:46.830 --> 00:01:03.090
Keivan Stassun: The the fundamental properties of individual stars on mass but importantly as we'll talk about today, helping us to develop a really new understanding and new picture of the structure in the in the local neighborhood.

11
00:01:04.320 --> 00:01:09.330
Keivan Stassun: Okay, so I will start by giving a sort of an overview of.

12
00:01:10.710 --> 00:01:30.090
Keivan Stassun: How the field has been progressing in terms of volume of data, specifically these ultra precise data and how we're combining them for measurements of fundamental stellar properties radio masses, etc, and then i'll hand it over to Marina who will pick up to talk specifically about.

13
00:01:31.620 --> 00:01:42.000
Keivan Stassun: Our understanding of precise stellar ages and how that, in turn, is shaping our understanding of the of the the history in the evolution of structure in the solar neighborhood okay.

14
00:01:42.750 --> 00:01:57.030
Keivan Stassun: So, in terms of these fundamental stellar data that we would like to have for as many stars as possible and under in order to understand stars individually, but also important in terms of populations.

15
00:01:57.870 --> 00:02:10.530
Keivan Stassun: 10 years ago just 10 years ago, this was sort of the state of the art in terms of precise trigonometric parallax is right, we had to order 100,000 good parallax his from his Marcos.

16
00:02:12.930 --> 00:02:28.650
Keivan Stassun: In terms of fundamental stellar properties like masters and radio, we had to order 100 or so benchmark eclipsing binary systems that folks like really Torres and myself have spent most of our careers, up to now working on.

17
00:02:29.970 --> 00:02:40.410
Keivan Stassun: In terms of you know hyper precise like curves time series photometer tree, you know, we had we were not yet in the era of kepler and tests and.

18
00:02:40.980 --> 00:02:50.250
Keivan Stassun: and so on and so really very small numbers of stars, for which astro seismology could be done right, I mean i've ordered 10 to the one right.

19
00:02:50.640 --> 00:02:59.610
Keivan Stassun: So that's where we were we'll revisit these numbers toward the end but next slide please Marina that was sort of the base, you know 10 years ago.

20
00:03:00.180 --> 00:03:12.480

Keivan Stassun: here now, just a few years later, we have this incredible explosion of data of these kinds right so in the in the image there what you see is.

21
00:03:12.840 --> 00:03:25.830
Keivan Stassun: A little yellow dot representing you know roughly the soul, the volume of space around the sun that hit parker's was able to reach this you're not to disparage parker's right new particles was incredibly important.

22
00:03:27.000 --> 00:03:47.520
Keivan Stassun: But that was our grasp in terms of volume Gaia Dr one already expanded our reach, to the Little Red circle there, and now, as we enter gaya Dr to and Dr three and beyond, you know we basically have access to incredibly precise.

23
00:03:48.600 --> 00:03:54.210
Keivan Stassun: distances and proper motions and so on for like you know this half of the galaxy.

24
00:03:55.230 --> 00:04:04.770
Keivan Stassun: At the same time, and within the same footprint test is delivering very precise light curves for millions and millions of stars.

25
00:04:05.580 --> 00:04:27.420
Keivan Stassun: And at the same time, and within the same volume sloan digital sky survey and other all sky surveys of highly multiplex spectra high resolution spectroscopy enabling detailed spectroscopic parameters again for stars by the millions and it's in combination this.

26
00:04:29.250 --> 00:04:34.380
Keivan Stassun: Data deluge of parallax is like curves and spectra.

27
00:04:35.460 --> 00:04:48.600
Keivan Stassun: That is really enabling the science that we're that we want to talk about today so next slide so let me give you just a feeling of what is now possible what is now newly possible with the advent of these kinds of data.

28
00:04:49.680 --> 00:05:03.000
Keivan Stassun: So one thing that we can now do is, we can measure the radius of stars very accurately as you no doubt know the radius of star is very important parameter it relates not only to the.

29
00:05:04.560 --> 00:05:10.890

Keivan Stassun: nature of the star itself but also is a key informant with respect to the stars evolutionary stage and age.

30
00:05:12.600 --> 00:05:26.820
Keivan Stassun: So I want to introduce this notion of pseudo interferometry Let me explain what I mean, so you know real interferometry is like the image of ontario's that you see there right that's a relatively recent.

31
00:05:27.600 --> 00:05:32.910
Keivan Stassun: You know fantastic technological achievement right, I mean if there was a tour de force.

32
00:05:34.080 --> 00:05:51.630
Keivan Stassun: accomplishment to measure the radius of another star to measure you know, to take an image of another star interfere symmetrically with like you know sub Milli Arc second precision okay that's real interferometry and you can do that for like 10 stars in the sky okay.

33
00:05:52.860 --> 00:06:01.740
Keivan Stassun: How do we get that level of precision of stellar radio for much larger numbers of stars next slide Well, now we can.

34
00:06:02.520 --> 00:06:17.160
Keivan Stassun: leverage the Stefan boltzmann relation basically because we can measure volumetric fluxes of stars thanks to all sky for a metric surveys and temperatures of stars thanks to spectroscopy for large numbers of star so advanced.

35
00:06:18.150 --> 00:06:23.370
Keivan Stassun: Here you see two spectral energy distributions representative of what we can now do.

36
00:06:23.940 --> 00:06:41.970
Keivan Stassun: These are two different stars were spanning from galaxy and the UV all the way out to wise and the MID ir we can just directly and empirically string together the bullet metric fluxes of stars with high precision and advanced one more Marina.

37
00:06:43.080 --> 00:06:52.260
Keivan Stassun: What you see here is a comparison of the angular diameters that have been measured, these are not to random stars, these are two stars that have actually been measured.

38

00:06:52.620 --> 00:07:07.410
Keivan Stassun: With real interferometry and you see that our pseudo interferon metric measurement of their diameters agree is perfectly with the real interferometry so we can really do this and we can do it with micro Arc second precision in fact next slide.

39
00:07:09.390 --> 00:07:15.840
Keivan Stassun: Here is from a paper that Karen Collins and Scott gowdy and I did a few years ago, taking.

40
00:07:16.260 --> 00:07:25.470
Keivan Stassun: The known exoplanet hosting stars, in particular, and applying the pseudo interferon metric method, and you can see the typical precision, that we can achieve is like.

41
00:07:25.800 --> 00:07:35.340
Keivan Stassun: A couple of micro arcseconds just you know, let that sink in for a second the units their micro Arc second precision on stellar radio.

42
00:07:36.060 --> 00:07:49.890
Keivan Stassun: And so, as you see, on the right already with Gaia Dr one, we were able to achieve fractional stellar radius uncertainties of like 123 percent out to distances of a couple hundred parsecs.

43
00:07:50.670 --> 00:07:59.400
Keivan Stassun: We plan to apply this with the guy a day or two and now guy a Dr three even more precise parallax is, we will be able to extend.

44
00:08:00.180 --> 00:08:09.480
Keivan Stassun: That preset that level of precision couple percent stellar radio couple percent stellar radio that used to be the province only of the best studied eclipsing binaries.

45
00:08:09.780 --> 00:08:16.560
Keivan Stassun: and interviews symmetrically measured stars couple percent stellar radio four stars out to a volume of a killer per SEC.

46
00:08:18.300 --> 00:08:18.720
Keivan Stassun: Okay.

47
00:08:19.830 --> 00:08:22.830
Keivan Stassun: I hope you think that's as exciting as I do next line.

48

00:08:24.270 --> 00:08:35.970
Keivan Stassun: And we can do more right so for stars that happened to be transmitted by planets we can take advantage of the information encoded in the transit, which basically tells us the mean stellar density.

49
00:08:36.420 --> 00:08:41.370
Keivan Stassun: I won't go through all the math but many of you are probably familiar with this, you can re express.

50
00:08:41.790 --> 00:08:51.840
Keivan Stassun: The properties of a planet transit in terms of I mean stellar density I just told you that I can pseudo interferon metric the measure the radio and large numbers of stars with high precision.

51
00:08:52.230 --> 00:09:05.730
Keivan Stassun: Transit gives me the mean stellar density to high precision now I can determine empirically in precisely the mass of that Star and, in turn, the mass and radius of the planet, that orbit next line.

52
00:09:07.260 --> 00:09:15.600
Keivan Stassun: And so, as of Gaia Dr one again with the planet hosting star stellar sample we showed that we could achieve.

53
00:09:16.200 --> 00:09:29.910
Keivan Stassun: few percent precision on stellar masses few percent precision stolen masses with guide year two and year three will be able to achieve that kind of stuff stolen mass precision again out to like a kilo per SEC.

54
00:09:31.050 --> 00:09:31.440
Keivan Stassun: Fine.

55
00:09:34.170 --> 00:09:47.280
Keivan Stassun: And then, finally, you know we can now, thanks to the incredible precision of light curves made possible by kepler and now tests, we can see, or at least measure.

56
00:09:47.910 --> 00:09:56.880
Keivan Stassun: The granularity in the surface grand elation of stars This was demonstrated by my former PhD student Fabian bastion and next slide.

57
00:09:58.890 --> 00:10:11.970

Keivan Stassun: This is just to show you just how good this stellar granular flicker is we just we measure this in the in the basically the excess noise of a kepler testflight curve, this is comparing the.

58
00:10:12.420 --> 00:10:22.530
Keivan Stassun: log G that we infer from graduation flicker on the y axis versus the long G that is known astro seismically for a benchmark set of stars.

59
00:10:23.880 --> 00:10:33.270
Keivan Stassun: And we've also showed that if you have spectroscopic medalists at ease, you can refine this even further, this is due to unknown effect having to do with the.

60
00:10:34.410 --> 00:10:38.340
Keivan Stassun: The influence of opacity on the basically the vigorous of.

61
00:10:39.570 --> 00:10:40.170
Keivan Stassun: Regulation.

62
00:10:41.190 --> 00:10:47.220
Keivan Stassun: We can we can infer log geez with a light curve, with a test like per capita like curve.

63
00:10:48.300 --> 00:11:00.240
Keivan Stassun: To like point 05 decks, and that is comparable to what you can achieve with luxury with a really good spectroscopic analysis so next slide.

64
00:11:04.320 --> 00:11:11.880
Keivan Stassun: If I measure the radius of a star pseudo interfere symmetrically and I measure its surface gravity.

65
00:11:12.930 --> 00:11:13.560
Keivan Stassun: flickr Lee.

66
00:11:15.840 --> 00:11:31.320
Keivan Stassun: I can measure the mass of that individual star I don't need another star orbiting it I don't need a planet transiting it I can basically self way a star by virtue of its surface gravity and its radius next slide are advanced.

67
00:11:32.400 --> 00:11:40.080

Keivan Stassun: And so, in terms of the number of stars that are now accessible to this level of precision.

68
00:11:42.060 --> 00:11:52.020
Keivan Stassun: With empirical measurements of pseudo pseudo into parametric radio and have this sort of you know self surface gravity mass technique.

69
00:11:52.440 --> 00:12:13.350
Keivan Stassun: You know we're talking about a lot of stars and so to my my good friend and collaborator really tourism, I think, is on the line I think we may be putting our our our ED cottage industry, business out of business, but that's Okay, this is this is tremendously exciting and so next slide.

70
00:12:15.090 --> 00:12:26.550
Keivan Stassun: So this is now where we've arrived in terms of the number of stars, where we can do you know really precise distances really precise masses and rady I.

71
00:12:27.780 --> 00:12:33.840
Keivan Stassun: Ultra precise for telemetry there's been an explosion as i'm sure you know and astro seismology.

72
00:12:35.430 --> 00:12:41.100
Keivan Stassun: I always say that you know these numbers, the leap doesn't look as impressive when you express it as exponent.

73
00:12:42.240 --> 00:12:45.270
Keivan Stassun: But really just you know, take a moment to appreciate what a.

74
00:12:47.610 --> 00:12:57.060
Keivan Stassun: What a leap this really this really represents and so having talked about fundamental properties of stars and the the leap that we are.

75
00:12:59.010 --> 00:13:07.380
Keivan Stassun: experiencing and benefiting from Marina will now talk about stellar ages and what we're learning about dollar structuring the solar neighborhood.

76
00:13:09.480 --> 00:13:10.290
Keivan Stassun: And thank you.

77
00:13:10.560 --> 00:13:11.730
Marina Kounkel: And i'll take over now.

78
00:13:12.870 --> 00:13:23.160
Marina Kounkel: So as came on has mentioned one of the things that has been among other properties that has been a historically difficult to measure for stars and mass have been stellar ages.

79
00:13:23.610 --> 00:13:33.090
Marina Kounkel: In particularly ages of eyeballs putin's to a few hundreds of millions of years, while the stars are still very young, while they're still part of.

80
00:13:33.660 --> 00:13:45.300
Marina Kounkel: embedded population still have this and stuff around them, we haven't been able to keep track of zone and shoes that we have been.

81
00:13:45.810 --> 00:13:51.060
Marina Kounkel: able to figure out sounds of the mental property that starts have when they are still just forming.

82
00:13:51.630 --> 00:14:04.620
Marina Kounkel: And, similarly to starts with properties of populations in which the stars have one is there still forming and the by looking at some nearby star from the region, this region citizen orion complex or scope son.

83
00:14:06.120 --> 00:14:25.620
Marina Kounkel: Some of the things that have become apparent is that these stuff on your regions are incredibly large as a span anywhere from huge 10s to hundreds of parsecs across some of them do have opened clusters that are building up, for example, the orion nebula, which is the.

84
00:14:27.390 --> 00:14:30.600
Marina Kounkel: most active start forming cluster that we have in this neighborhood.

85
00:14:31.740 --> 00:14:45.840
Marina Kounkel: But, in large part, even so, people frequently say most starts from in clusters clusters in Stefan regions are relatively rare and some stuff from the regions militarily have clusters at all the stores, for example.

86
00:14:47.520 --> 00:15:03.390
Marina Kounkel: The Southern Region sent the form anywhere from a few hundred stars to several thousands of stores on the low mass and you have again for us, which I think has only two or 300 stars on the other, Andy have orion nebula which has on the order of 10,000 stores.

87
00:15:04.590 --> 00:15:14.760
Marina Kounkel: And furthermore z's start from your regions tend to be very dynamically cold the stars that are forming inside them have the same.

88
00:15:15.450 --> 00:15:28.350
Marina Kounkel: velocity as a cloud that originally produced some extensive stands to reason that these populations will remain as Co moving groups for a considerable period of time.

89
00:15:29.430 --> 00:15:33.660
Marina Kounkel: have something on the order of maybe few 10s of hundreds of millions of years.

90
00:15:34.560 --> 00:15:41.970
Marina Kounkel: And by that logic, because we know that everything is forming dynamically cold and all over such large spatial skills.

91
00:15:42.660 --> 00:15:56.850
Marina Kounkel: When we look at 10 2050 hundred million million year old open clusters, should we expect them to be completely isolated and cluster like or should we expect to find an extended moving group HALO around them.

92
00:15:58.200 --> 00:16:10.260
Marina Kounkel: Well, finding moving groups have been missing you poor for a long time in in the past to have known approximately a dozen or so moving groups within the volume of space of 100 parsecs.

93
00:16:11.640 --> 00:16:21.960
Marina Kounkel: but very few have been known beyond that, for a fairly good reason, in order to find the moving group, you need to have information on the velocities and promotions or the stars across the entire sky.

94
00:16:22.470 --> 00:16:36.300
Marina Kounkel: And until recently, the best source of promotions came from the supermarket survey which didn't really have much sensitivity or

resolution beyond 100 prospects, but now, with Gaia we can push the boundary just a bit further.

95
00:16:37.740 --> 00:16:43.860
Marina Kounkel: So we have performed here here are called clustering on the guide your to data.

96
00:16:45.150 --> 00:16:57.600
Marina Kounkel: trying to find clusters and moving groups and associations and in total going up to streaker parsecs was inserted degrees of the galactic plane, we found over 8000 different groups.

97
00:16:58.650 --> 00:17:16.680
Marina Kounkel: And they are shown in blue and in comparison you see, there are, as a yellow dots they are tracing some of the previously known open clusters in the same on your space and, as you can see interval spatial coverage, we are looking at something that is very, very different scale.

98
00:17:18.000 --> 00:17:25.650
Marina Kounkel: And, in total, this these 8000 different populations account for almost 1 billion stars.

99
00:17:26.250 --> 00:17:36.030
Marina Kounkel: and presumably if the stars are to form together as moving groups, they should have more or less the same as their voice Is it really possible to determine their age.

100
00:17:36.540 --> 00:17:45.330
Marina Kounkel: Through ice cream for the for the entire starts in the population at once, and we do have quite nice ice creams for Muslims populations.

101
00:17:45.930 --> 00:17:56.700
Marina Kounkel: So you can see how the youngest population is shown in red still have a sizable premium sequence, and they are evolving down and fall onto the main sequence, and then, as the stars age.

102
00:17:57.150 --> 00:18:04.650
Marina Kounkel: Beyond the hundred million years in the Green and purple the high math starts it starts to evolve away from the main sequence and dying off.

103
00:18:05.220 --> 00:18:15.540

Marina Kounkel: So with this we are able to derive quite precise stellar ages for almost a million stars, which I think to date is the largest catalog of starts with non ages.

104
00:18:16.860 --> 00:18:20.700
Marina Kounkel: And we can use this information to color Code, the.

105
00:18:21.840 --> 00:18:29.520
Marina Kounkel: Old all of your patients in all the various protection that you want to connect to the first block is a position on the sky that we were looking at before.

106
00:18:30.060 --> 00:18:48.090
Marina Kounkel: As and the next panel is l vs parallax, then the last three rl versus we are useful, so you can balance and it looks very busy so let's just take an age range and look at it in a bit more detail so right now we're looking at the stars younger than around 30 million years.

107
00:18:49.650 --> 00:19:01.980
Marina Kounkel: And what becomes apparent particularly looking at the middle panel, in particular as well, different populations have different peculiar velocity relative to one another, obviously.

108
00:19:02.760 --> 00:19:17.700
Marina Kounkel: But, more importantly, a single population can remain coherent for several dozens degrees in the plane of sky or in physical units for several hundred parsecs on the order of 200 and, in fact.

109
00:19:18.720 --> 00:19:27.360
Marina Kounkel: They kind of remains is in remain trip trip like a string in all of the projections, so it is again most strongly.

110
00:19:27.990 --> 00:19:37.530
Marina Kounkel: apparent in El versus a promotion in the other component, but, as you can see, we have these elementary strengths in all of the.

111
00:19:38.340 --> 00:19:41.880
Marina Kounkel: components of the face space, including radio velocities now.

112
00:19:42.810 --> 00:19:49.440
Marina Kounkel: I like the promotion sky does not have quite as many radiographs these and they're not quite as precise.

113
00:19:49.710 --> 00:19:56.250
Marina Kounkel: So we haven't been clustering in that particular portion of the observation space, but the fact that we do see the same coherence.

114
00:19:56.550 --> 00:20:06.180
Marina Kounkel: And smooths variations in rbs as we do have in program officer position the sky shows us of these strengths are indeed quite feel that they are physical structures.

115
00:20:08.490 --> 00:20:18.000
Marina Kounkel: And well good good enough or when we're looking at, as a young populations, what about if you were to look at something a bit older let's say on the order for giga year.

116
00:20:18.840 --> 00:20:40.320
Marina Kounkel: now starting to much busier but was so careful during a careful poking and trying to tug on various populations by hand, it is possible to identify the strengths, even at these agents that still remain for elementary in all of them in all the projections.

117
00:20:41.760 --> 00:20:50.970
Marina Kounkel: So, looking at the sample as a whole and separating it explicitly as a function of each into the young stars and the old stars.

118
00:20:51.360 --> 00:21:01.560
Marina Kounkel: And separating them out into this long strength of stars that may have a cluster somewhere inside them or they may not necessarily have a cluster.

119
00:21:02.100 --> 00:21:16.770
Marina Kounkel: inside them versus these more compact more isolated groups of stars that don't have these extended halos we find that strengths are ubiquitous at the younger ages and they tend to be very sharply defined.

120
00:21:17.670 --> 00:21:29.220
Marina Kounkel: In contrast, only a few stars relatively are found in the more compact more isolated groups on the other hand, as an older ages most stars.

121
00:21:30.120 --> 00:21:40.950
Marina Kounkel: That are still close trouble tend to be in this contract groups was still a few rather diffuse strengths hamp out looking at it in a different way.

122
00:21:41.850 --> 00:21:51.180
Marina Kounkel: Okay, the histogram of the number of sources as a function of age, once again, this young stars 20 primarily found in strengths.

123
00:21:52.080 --> 00:22:06.870
Marina Kounkel: But the strength to go away after in a different 100 to 300 million years on the other hand, the small compact more cluster like a groups don't tend to come into prominence until the age of around 300 million years.

124
00:22:09.780 --> 00:22:25.890
Marina Kounkel: And also looking at the number of stars per given population, we find that at the younger ages, it is possible to have anywhere from a few hundred stores do several thousands of stores, but, as these populations age, it is rare to find.

125
00:22:27.300 --> 00:22:44.280
Marina Kounkel: At the populations that are over a year or more than a few dozens of stalkers so there's this envelope by which the populations starting to lose their mass and most likely the violation that we're still able to recover as the evolved ages have started out somewhere over here.

126
00:22:46.950 --> 00:23:04.740
Marina Kounkel: So, with this in mind, what is the origin of this xml structure of the strengths, well, it is unlikely to be caused by title stretching of previously compact clusters, otherwise you would expect them to start compact and then stretch out rather than the other way around.

127
00:23:05.970 --> 00:23:13.410
Marina Kounkel: For some more not every string even contains a cluster sounds i'm do, as I mentioned some of them don't.

128
00:23:14.160 --> 00:23:19.590
Marina Kounkel: The cluster does not have to be at the Center the Costa hadn't be anywhere along the string if this present.

129
00:23:20.460 --> 00:23:32.340
Marina Kounkel: Rather, it is likely that we are creating the primordial structure of the populations, we know that stars form in giant multiple clouds clouds of self supplementary in nature.

130
00:23:33.270 --> 00:23:42.390

Marina Kounkel: And it sent the reason that when you have gas ego to start forming stars, so the population that form inside those clouds was still going to trace the morphology.

131
00:23:43.050 --> 00:23:53.040
Marina Kounkel: Of these lemon tree clouds and these regulations are slowly evolving over time, they are losing stars into the galaxy as they are relaxing.

132
00:23:54.540 --> 00:23:56.790
Marina Kounkel: Over over several.

133
00:23:57.960 --> 00:24:12.960
Marina Kounkel: Dozens or hundreds of millions of years, only the dentist and most cluster like parts are going to be left behind, was what was the other acts in the healers being lost from being able to be edited numerically but it's not the most massive wants.

134
00:24:13.980 --> 00:24:18.450
Marina Kounkel: Something that has the mass of the orion complex will be able to persist.

135
00:24:19.980 --> 00:24:23.940
Marina Kounkel: it's extended form for several hundreds of millions of years.

136
00:24:26.100 --> 00:24:31.080
Marina Kounkel: So switching gears a bit and looking at everything in 3D now.

137
00:24:32.190 --> 00:24:42.090
Marina Kounkel: So right now we're looking down on the plane of the galaxy with the sun being at the Center of this block the galactic Center is to the right of this image.

138
00:24:42.690 --> 00:25:04.080
Marina Kounkel: Here we have the three spiral arms that are being captured within this folio space, here we have the secretary yes arm, here we have the local arm and, more generally, referred to as the radcliffe wave, and here we have the perseus arm and all the strengths.

139
00:25:05.160 --> 00:25:16.230
Marina Kounkel: That are younger than 50 million years are being traced along the spine to be placed in these in the 3D block and we're finding is that they are not.

140
00:25:17.370 --> 00:25:24.360
Marina Kounkel: Their orientation is not random they tend to be oriented in parallel to one another perpendicular to whatever spiral arm they're found next.

141
00:25:25.830 --> 00:25:37.200
Marina Kounkel: And because these stars young starts to form in strength that gives a suggestion that there must be some sort of dominant process that is driving this mythology.

142
00:25:38.820 --> 00:25:51.930
Marina Kounkel: And curiously when people look at other galaxies in high resolution guests surveys they're finding is East gashes feathers recruiting perpendicularly away from the spiral arm.

143
00:25:52.710 --> 00:26:14.340
Marina Kounkel: Now again whenever I go going to have star a gassy going to start forming stars, so perhaps these strengths of stars and these gashes feathers are connected, perhaps this is the driving force that is responsible for forming as a giant part of our clouds in our own so our neighborhood.

144
00:26:16.080 --> 00:26:20.730
Marina Kounkel: So with that, I think we are running out of time for our portion of the presentation.

145
00:26:21.270 --> 00:26:32.190
Marina Kounkel: And just to summarize again over the last decade or so was the advancement of these very, very large survey, such as Guy as address as the SS such as kepler and thus.

146
00:26:32.910 --> 00:26:46.530
Marina Kounkel: We are starting to develop a wealth of information that has already shown us a lot of incredible things and we will be able to continue that the combine the survey data in the future.

147
00:26:47.640 --> 00:26:48.030
Thank you.

148
00:26:51.990 --> 00:27:01.950
Morgan Elowe MacLeod: Thank you, both this is really amazing work I think it's really amazing to think about all the information that we're now privy to and.

149
00:27:02.370 --> 00:27:11.640
Morgan Elowe MacLeod: Really amazing Marina to see how, when we start digging into that weekend a whole new picture of you know, our closest part of the universe and.

150
00:27:12.600 --> 00:27:21.690
Morgan Elowe MacLeod: It as amazing as it is to like look out as far as we can it's also kind of amazing to realize how little or how much we have to learn, closer to home.

151
00:27:21.930 --> 00:27:22.440
So.

152
00:27:23.610 --> 00:27:30.600
Morgan Elowe MacLeod: With that in mind let's let's let's open it up to discussion so remember if you wanted to go ahead and unmute.

153
00:27:33.540 --> 00:27:57.150
Ramesh Narayan: Sure um yeah So my question is to Kevin first part of the talk it's brilliant to have so many accurate Radia up with you're using the Stephen boltzmann law, and I can see that you get the rf volumetric happily from all the data spectral data, but there is the T effective and.

154
00:27:58.290 --> 00:28:09.720
Ramesh Narayan: People often apply something called a color correction, or maybe they model, the spectrum using a stellar atmosphere, so how exactly do you do that because that's where the systematic error could come in.

155
00:28:10.260 --> 00:28:17.610
Ramesh Narayan: How you relate the effective from observations to the correct tea that should go into the Stephen boltzmann law.

156
00:28:20.430 --> 00:28:27.390
Keivan Stassun: yeah that's a great question and it borders on the philosophical, in the sense that.

157
00:28:30.180 --> 00:28:40.500
Keivan Stassun: Right, the reason that we call it T effective specifically is because it's T effective is that quantity, that is defined to make the stuff on baltimore relation work.

158
00:28:41.910 --> 00:28:46.620

Keivan Stassun: So there's a there's always a little bit of circularity with this, but to answer your question directly.

159
00:28:49.050 --> 00:28:59.070
Keivan Stassun: You know when you're doing this kind of work at scale, you know, in practice, right what you do is you, you you take advantage of the best.

160
00:28:59.670 --> 00:29:07.710
Keivan Stassun: temperatures, the best T effective that you can get your hands on which, in general, are going to come from a variety of sources.

161
00:29:08.610 --> 00:29:16.020
Keivan Stassun: If you limit yourself to just those T effective that have been determined spectroscopic the message to some through spectroscopic analysis.

162
00:29:16.950 --> 00:29:29.220
Keivan Stassun: Then, indeed, as you said, what we find is that the limiting factor on the on the ultimate accuracy of the stellar radio is whatever systematic uncertainties.

163
00:29:29.700 --> 00:29:41.070
Keivan Stassun: You believe are associated with those temperatures, because there are different temperature scales or different corrections that one might or might not apply as a function of spectral type and what have you.

164
00:29:42.900 --> 00:29:46.710
Keivan Stassun: But, in general, you know the the the.

165
00:29:48.270 --> 00:29:53.130
Keivan Stassun: The degree to which these different temperature scales and corrections and what have you.

166
00:29:54.180 --> 00:30:07.410
Keivan Stassun: Have have systematic uncertainties, you know for solar type star say 6000 kelvin star you're probably talking about 100 kelvin of order for those systematic uncertainties right.

167
00:30:09.750 --> 00:30:18.510
Keivan Stassun: And so, and so that, indeed, you know, given how good the parallax is our and given the fact that the bullet metro fluxes can now be measured very precisely.

168
00:30:18.960 --> 00:30:33.840
Keivan Stassun: And the balloon metric flux enters into the radius calculation to the square root it's that 100 kelvin systematic uncertainty on the temperature that basically dominates the entire Arab budget but you're still you still end up in the domain of a few percent yeah.

169
00:30:34.050 --> 00:30:45.090
Ramesh Narayan: that's amazing yeah and you know you did show the couple of stars where your method gives a radius that agrees perfectly with the eclipse data know it's wonderful.

170
00:30:46.530 --> 00:30:54.060
Marina Kounkel: Also to jump in on here, even when temperatures determines microscopically there are a lot of wiggle room.

171
00:30:54.840 --> 00:31:05.430
Marina Kounkel: For example, if you're taking at the spectra in the optical versus in the near infrared as on the temperature going to be slightly different just because you have a different capacity.

172
00:31:05.970 --> 00:31:19.140
Marina Kounkel: and are working closely with a survey data, there are a lot of headaches and actually measuring the temperatures precisely and what systematics are you going to have based on which just.

173
00:31:19.800 --> 00:31:30.450
Marina Kounkel: said that if models so even when effective temperatures are determined topically there is going to be some systematic wiggle room but it's comparable.

174
00:31:31.980 --> 00:31:36.180
Keivan Stassun: Would you agree that of order 100 Calvinism yeah.

175
00:31:38.670 --> 00:31:41.970
Morgan Elowe MacLeod: Film did you want to go ahead and enter this conversation.

176
00:31:43.560 --> 00:31:47.220
Phillip Cargile: yeah so I guess having the same a cave on Nice nice to see you again.

177
00:31:49.380 --> 00:32:00.810

Phillip Cargile: I had a question kind of similar vein, but maybe a different angle, which is that, as we know, we're going quickly into into a systematic dominated regime where systematics.

178
00:32:01.320 --> 00:32:11.220
Phillip Cargile: matter and you came on your own you're very familiar with the Gaia parallax systematics hopefully I mean he Dr T looks like a little bit better than Dr to.

179
00:32:11.820 --> 00:32:27.630
Phillip Cargile: But what other systematics are dominating our accuracy of you know, is it is it the fundamental zero points what what is the that we really need to work on, to try to try to get our accuracy as good as possible.

180
00:32:29.850 --> 00:32:33.210
Keivan Stassun: yeah good question so again if you're thinking about radio.

181
00:32:34.560 --> 00:32:37.650
Keivan Stassun: stellar radio right there are basically three.

182
00:32:38.880 --> 00:32:46.920
Keivan Stassun: measurable goals that enter into that calculation directly there's the parallax right the radius depends.

183
00:32:47.640 --> 00:32:55.740
Keivan Stassun: One one to one with the parallax and therefore with the uncertainty there's a bowl of metric flux, the radius depends on will match up flux, to the one half power.

184
00:32:56.310 --> 00:33:10.710
Keivan Stassun: And then there's the temperature the radius depends on the temperature squared so just in terms of you know, thinking about air budget temperature by far the systematics in the in the temperature scales as we've just been discussing are kind of the most.

185
00:33:12.600 --> 00:33:19.230
Keivan Stassun: persistently problematic and your radius depends on that temperature, the most so that's the number one.

186
00:33:21.150 --> 00:33:28.830
Keivan Stassun: You know parallax that you know there's the one to one dependence, but, as you know, the Gaia data releases march on.

187
00:33:30.240 --> 00:33:38.940
Keivan Stassun: Not only have I mean a Willie tours and I just looked at the Dr three systematics with the benchmark eclipsing binaries and we no longer find a significant.

188
00:33:39.510 --> 00:33:47.580
Keivan Stassun: Systematic offset whereas by the end or one we found a big one, so the systematic are getting rapidly be down in the parallax is.

189
00:33:48.360 --> 00:33:55.230
Keivan Stassun: The volume over which you can access really you know high precision parallax is is that steadily increasing.

190
00:33:55.740 --> 00:34:01.710
Keivan Stassun: The radius depends, you know, only one to one on that, so I think parallax is I think we're good there.

191
00:34:02.220 --> 00:34:16.440
Keivan Stassun: But the metric fluxes is interesting because indeed you know when you're stringing together galaxy to to mass to wise, you know they're you're necessarily going to be susceptible to some degree to those.

192
00:34:17.610 --> 00:34:19.110
Keivan Stassun: For the metric zero points.

193
00:34:20.730 --> 00:34:24.660
Keivan Stassun: And we've looked at that, and you know the the photo metric zero points.

194
00:34:25.680 --> 00:34:34.170
Keivan Stassun: The systematic uncertainties between for metric systems again take comparing galaxy to to mass you're talking like two 3%.

195
00:34:35.460 --> 00:34:39.210
Keivan Stassun: And so, where your radius goes like the bullet metric flux, to the one half.

196
00:34:40.740 --> 00:34:50.280
Keivan Stassun: You know that's just that's not dominating your era budget so anyway long answer to say we gotta we just gotta keep working on those temperatures scales.

197
00:34:51.330 --> 00:34:53.760
Marina Kounkel: yeah and another thing that.

198
00:34:55.500 --> 00:34:57.060
Marina Kounkel: interval systematics that.

199
00:34:58.320 --> 00:35:03.000
Marina Kounkel: Can strongly effect the data are not necessarily the data themselves what's the models.

200
00:35:03.480 --> 00:35:14.340
Marina Kounkel: So, in the past, I saying it's will be fair to say that models have been more precise in the data, and right now it's the opposite right now is a data or more precise in the models and, for example, things like I said crowns.

201
00:35:15.360 --> 00:35:19.560
Marina Kounkel: ISO crowns are notoriously a bad fit to the main sequence.

202
00:35:20.670 --> 00:35:28.650
Marina Kounkel: There, especially on the low mass and so depending on if you want to look at the individual star or individual population, if you want to.

203
00:35:29.130 --> 00:35:40.920
Marina Kounkel: Send that expect for of stars and comparing that to do the data and some more discrepancies or is as a more systematic seven producers and I love, unfortunately, something.

204
00:35:41.580 --> 00:35:50.910
Marina Kounkel: That we're still thinking about how to fix but some of the more data driven approaches, where you have a golden standard of sources.

205
00:35:51.450 --> 00:36:06.450
Marina Kounkel: That, for which we do more or less know the answer be from these obey in perfect models and then using these data across the rest of the sample tends to minimize these model live in a systematic submit.

206
00:36:07.740 --> 00:36:15.750

Phillip Cargile: I totally agree that I think I think having a calibration samples is really important, I know, here we use the guy use of benchmarking sample and things like that.

207
00:36:16.200 --> 00:36:30.720
Phillip Cargile: Essentially, the problem that we we run into is once you start reaching out to 123 10 K PC you start getting seller populations that don't have any type of calibration metal poor samples, you know and things like that, where.

208
00:36:31.170 --> 00:36:39.690
Phillip Cargile: It would be great to calibrate your ice cream against against some some metal poor calibration star or something like that, but unfortunately out there yeah yeah absolutely.

209
00:36:40.650 --> 00:37:00.000
Keivan Stassun: I should quickly plug, by the way, spirits, which I think will be hugely beneficial for a lot of this discussion right the you know the prospect of having in one system spectral photo metric leafleting you know flux calibrated fluxes from you know from the optical into the near ir.

210
00:37:01.650 --> 00:37:11.970
Keivan Stassun: We started looking at what's going to be possible when you basically just directly measure the spectral energy distribution in one go that'll that's going to help a lot.

211
00:37:15.930 --> 00:37:23.250
Morgan Elowe MacLeod: So maybe we can shift gears a tiny bit and start talking a little bit about some of the structure that emerges, so I know alyssa had a question about that.

212
00:37:26.250 --> 00:37:30.600
Alyssa Goodman: hi i'm rena I gave on this to see you thanks thanks for doing this.

213
00:37:31.110 --> 00:37:41.670
Alyssa Goodman: So I just have a question about i'm sorry i'm looking at a screen that's up there i'll try to look here um I have a question about the strings Marina, and so I have seen the paper just a little bit, but could you say for everybody.

214
00:37:42.270 --> 00:37:47.160
Alyssa Goodman: How those strings are defined, and whether they're robust to the technique that you use.

215
00:37:48.120 --> 00:37:49.650
Marina Kounkel: So originally.

216
00:37:51.090 --> 00:38:03.420
Marina Kounkel: we've just from clustering on the data and we've used http scan which is and the clustering algorithm that is a bit more insensitive to the variation of density.

217
00:38:04.080 --> 00:38:16.230
Marina Kounkel: For most clustering algorithms if you have to dance class starts right next to one another, they would join them, and if you have a huge population ours, and it might completely completely miss it, but he be scan is is able to.

218
00:38:17.400 --> 00:38:29.520
Marina Kounkel: be a bit more invariant to the density in that it will be able to separate to those clusters next to another and to be able to find the more diffuse populations in the same room, but unfortunately it sometimes.

219
00:38:30.630 --> 00:38:38.190
Marina Kounkel: Especially when you're looking at the more nearby stuff truncate thing so but, for example, here we have the upper SCO might separate into the.

220
00:38:38.940 --> 00:38:46.080
Marina Kounkel: upper school about the Cisco Sunday night separated the dropper skirt myself right and and also see unconscious chalice and all the other parts.

221
00:38:46.650 --> 00:39:02.550
Marina Kounkel: But, as I was looking through all of these different projections, I was trying to group together things that appear to be most moving in the in all of the dimensions so trying to connect by.

222
00:39:04.080 --> 00:39:12.630
Marina Kounkel: All of the all of the sentence structure when you're looking at a more extended regions than there isn't quite as much fragmentation.

223
00:39:14.940 --> 00:39:19.890
Alyssa Goodman: So i'm so the the the, the answer is it that you did most of this is all right.

224

00:39:20.100 --> 00:39:31.410
Marina Kounkel: yeah so originally there has been a sample of startup has been clustered and then looking at that sample kind of looking at start using this as a starting point, I would I would look.

225
00:39:32.700 --> 00:39:41.850
Marina Kounkel: Here, for example, there's northern city all right let's select the server density and see where it lands in all of the other pilot productions and through this we are able to separate them out.

226
00:39:45.330 --> 00:39:46.830
got it thanks.

227
00:40:12.360 --> 00:40:13.560
Marina Kounkel: Other other.

228
00:40:14.010 --> 00:40:16.590
Keivan Stassun: Morgan you're muted, by the way, that I do see one of the.

229
00:40:16.620 --> 00:40:18.390
Morgan Elowe MacLeod: Oh i'm so sorry I was talking but.

230
00:40:18.390 --> 00:40:19.110
Morgan Elowe MacLeod: I was muted.

231
00:40:22.200 --> 00:40:23.760
Morgan Elowe MacLeod: yeah Thank you go ahead, you.

232
00:40:25.320 --> 00:40:26.160
Yue Cao: Know Thank you.

233
00:40:28.560 --> 00:40:28.770
Yue Cao: Very.

234
00:40:30.240 --> 00:40:31.650
Yue Cao: very interesting to see the.

235
00:40:32.880 --> 00:40:34.020
Yue Cao: nation of the.

236
00:40:35.070 --> 00:40:38.310

Yue Cao: stars in groups of students with the Malacca calls.

237
00:40:39.570 --> 00:40:40.980
Yue Cao: Just two comments here.

238
00:40:42.180 --> 00:40:42.960
Yue Cao: The first line that.

239
00:40:44.130 --> 00:40:46.860
Yue Cao: This things in this with this.

240
00:40:47.910 --> 00:40:55.080
Yue Cao: clearing the last is just to remind me after the Austin coherence, doctors, when I can upload images found by.

241
00:40:57.480 --> 00:41:01.530
Yue Cao: inspecting the position position velocity after without the cloud with.

242
00:41:02.790 --> 00:41:06.000
Yue Cao: Some structure lines and he also found that these.

243
00:41:07.050 --> 00:41:08.160
Yue Cao: Fundamental squares was.

244
00:41:09.210 --> 00:41:14.100
Yue Cao: Comparing the last things, but I think they are on two different scales.

245
00:41:15.240 --> 00:41:34.590
Yue Cao: And for for those other structures, some about the electrical on several parts that scale, but but for for the strings on the roots you so it's about much larger so, but you still are interesting to see the similarity.

246
00:41:35.730 --> 00:41:36.390
Marina Kounkel: So.

247
00:41:36.780 --> 00:41:42.060
Marina Kounkel: Also internal clouds clouds can get quite large on there is.

248

00:41:43.830 --> 00:41:59.910
Marina Kounkel: There was a survey by catherine's occur, of the all sorts of different types of clouds and there are some that are more compact, but there are some that are really, really, really huge and even in those large ones I seen the wealthiest person is still under this couple of seconds.

249
00:42:00.720 --> 00:42:07.500
Yue Cao: yeah so that could be very interesting to see what it out some cancellations another Another point is.

250
00:42:09.150 --> 00:42:13.650
Yue Cao: The size and have lost the dispersion over that politics, which is.

251
00:42:15.300 --> 00:42:19.650
Yue Cao: often called by the margins most and make.

252
00:42:21.060 --> 00:42:22.680
Yue Cao: It and it is related to the.

253
00:42:24.090 --> 00:42:24.600
Yue Cao: Intensive.

254
00:42:25.950 --> 00:42:26.550
Yue Cao: turbulence.

255
00:42:27.930 --> 00:42:33.060
Yue Cao: of turbulence and also i've seen a paper recently on.

256
00:42:34.200 --> 00:42:34.680
Yue Cao: Alaska.

257
00:42:36.000 --> 00:42:42.360
Yue Cao: Major Estonia on studying the mass and the velocity aspersions on this others.

258
00:42:43.680 --> 00:42:50.820
Yue Cao: star star clusters in his talk on the regions and they found such a very similar in relation.

259
00:42:52.560 --> 00:42:55.170
Yue Cao: To the largest law, which is very interesting interesting.

260
00:42:59.520 --> 00:43:06.420
Yue Cao: interesting to see this size and what's this personal relationship with such a large body of data.

261
00:43:07.080 --> 00:43:19.380
Marina Kounkel: Yes, absolutely and the we have looked at it in a couple of regions and for the most part, I think they do tend to follow Larson law, but one of them to ease my way into the slide here, we have our iron.

262
00:43:19.920 --> 00:43:28.860
Marina Kounkel: In this red blob and you know ryan's there have been several supernovae and they actually inject turbulence into into the gas and stars so.

263
00:43:29.400 --> 00:43:44.580
Marina Kounkel: There we are actually able to see this injection of turbulence in the voltage percent of the stars so even though it's still quite low it's less than five seconds there across the entire Ryan complex, but we are able to see this extra bit of turbulence that.

264
00:43:45.660 --> 00:43:46.980
Marina Kounkel: Is from a supernova interaction.

265
00:43:48.060 --> 00:43:54.570
Yue Cao: goes to just introduce sequel injection co chairs the relation.

266
00:43:55.200 --> 00:43:56.700
Marina Kounkel: Oh yeah so so it.

267
00:43:58.020 --> 00:44:12.270
Marina Kounkel: Yes, i'm asked if the supernova has changed much of the morphology off of the of the complex, it has triggered star formation at has allowed the formation of the formation of the orion nebula and it.

268
00:44:13.530 --> 00:44:15.900
Marina Kounkel: changed the overall will excuse me, yes.

269
00:44:16.920 --> 00:44:17.250
Yue Cao: Thank you.

270
00:44:21.180 --> 00:44:21.990

Very much yeah.

271
00:44:24.150 --> 00:44:26.040
Ramesh Narayan: Sorry, I don't want to dominate the.

272
00:44:26.040 --> 00:44:27.750
Morgan Elowe MacLeod: Discussion Now this is great, but.

273
00:44:27.960 --> 00:44:38.040
Ramesh Narayan: But you know, every time I listen to a talk that involves guy our data I just walk away thinking what a miraculous you know project, it is.

274
00:44:38.340 --> 00:44:45.180
Ramesh Narayan: yeah today, the big big thing that taught me was in one of your early slides K one you showed.

275
00:44:46.050 --> 00:45:04.890
Ramesh Narayan: How the Dr one data gave us information on some distance and then by the time you go to Dr to Dr three say huge increase in volume and when you think of it as volume going, as you know, distance cube you know just it's just mind blowing, why is it so good, you know.

276
00:45:07.320 --> 00:45:21.600
Ramesh Narayan: The duration I don't mean a white guy so good, they designed it great but i'm just trying to understand what is it are we just getting a better handle on systematics because the root and to me doesn't seem like it can grow this fast in volume.

277
00:45:25.020 --> 00:45:39.390
Keivan Stassun: yeah that's that's a good question and I will confess that my my knowledge of the the technical details of you know, in terms of the detectors and the scanning strategy and so on.

278
00:45:41.280 --> 00:45:42.090
Keivan Stassun: is limited.

279
00:45:43.530 --> 00:45:55.710
Keivan Stassun: You know, you know you know, obviously it's not like you know Gaia was on some you know larger or different you know you know orbit or something right, I mean.

280
00:45:56.370 --> 00:46:12.360

Keivan Stassun: You know I mean gaya like hip Marcos is on the same one, a new baseline that hip Marcos was so you know that so that right there tells you that the advanced is really entirely in terms of technique and detector sensitivity.

281
00:46:13.620 --> 00:46:18.240
Keivan Stassun: But truly at a more technical detail I don't I don't have the answer for you.

282
00:46:18.780 --> 00:46:35.820
Ramesh Narayan: Somebody probably knows in the audience, you know sure you get more data if you were to 2022 compared to 2017 but you know the relative size of those two volumes is at least, you know as a dumb theorist I am i'm kind of struck.

283
00:46:37.290 --> 00:46:39.270
Morgan Elowe MacLeod: As I understand it, it isn't like route.

284
00:46:39.510 --> 00:46:40.410
Morgan Elowe MacLeod: Time right.

285
00:46:40.440 --> 00:46:42.600
Morgan Elowe MacLeod: No Maybe someone who actually knows can.

286
00:46:43.410 --> 00:46:43.980
Morgan Elowe MacLeod: add that in.

287
00:46:44.070 --> 00:46:53.910
Marina Kounkel: detail so sensitivity is a big thing is a guy is of around 100 times more sensitive, maybe even 1000 times worse and so what's your purpose, so that.

288
00:46:54.330 --> 00:47:07.890
Marina Kounkel: alone gives you more stars that are further away, but also it has much better since joining, so that you are able to keep track off the position of the stars over time my.

289
00:47:08.760 --> 00:47:21.420
Marina Kounkel: Much better big systematic in trying to do this analysis is that all the stars along the lines of the same line of sight are going to be moving in the same direction.

290
00:47:22.170 --> 00:47:41.430

Marina Kounkel: or as a as a from the effects of the parallax and so by using the two different erase the operating model yes Lee they're able to get better centroid things better us a better better pixel scale and everything else, so that gives you a better precision as well.

291
00:47:43.980 --> 00:47:45.570
Morgan Elowe MacLeod: Catherine, do you want to jump in.

292
00:47:46.440 --> 00:47:57.330
Catherine Zucker: Yes, I have a question for Marina so my understanding is that you think that many of these strings have to form Institute, so they have to form in these highly elongated clouds.

293
00:47:57.780 --> 00:48:04.590
Catherine Zucker: And so, thanks for the shout out I do study, a lot of highly supplementary molecular clouds and particular I know there's not.

294
00:48:05.640 --> 00:48:15.990
Catherine Zucker: These are not too common in the galaxy to get these highly elongated filaments I think I estimated there's on the order of thousands and the whole Milky Way and some curious if you have other evolutionary pathways.

295
00:48:16.530 --> 00:48:24.060
Catherine Zucker: For how to form these strings when they're not being stretched out by galactic rotation or differential rotation, as they as they evolve.

296
00:48:25.350 --> 00:48:29.640
Marina Kounkel: Well i'm not that many.

297
00:48:30.960 --> 00:48:46.320
Marina Kounkel: All of them for me in situ, it makes it a bit easier, that we are averaging over time, so, even so, you might have one or two, for me, at a given time asked you are averaging over as a 50 or 100 million years you're going to find more of them.

298
00:48:47.430 --> 00:48:56.970
Marina Kounkel: Just that are still being remnants of the clouds themselves are tend to be fairly forklift they go away after after a couple of million years or if lessons up.

299
00:48:57.630 --> 00:49:07.890

Marina Kounkel: But these strings of stars were able to keep track of for much longer, so that is probably the best way I can think of, to reconcile the difference in numbers.

300
00:49:09.000 --> 00:49:09.420
Marina Kounkel: But but.

301
00:49:10.290 --> 00:49:18.360
Catherine Zucker: yeah sorry to interrupt but the arguments in this diagram right here, so this is going out so like to kill parsecs so is the arguments still that all these strings are forming and.

302
00:49:18.720 --> 00:49:27.330
Catherine Zucker: Highly elongated clouds given that they're so young right so they're less than 50 mega years yeah it's a consequence of averaging over time or yeah.

303
00:49:27.480 --> 00:49:43.950
Marina Kounkel: So here, almost all of them to have any gas anymore, so there are some exceptions of course here we have arrived, and although those orion is here, this is perseus and perseus for the most part, has depleted and gas has had a couple of clouds leftover.

304
00:49:45.870 --> 00:49:56.010
Marina Kounkel: Have you go sit over here, there are a couple of other gas gas buried kind of the reddest once still make some gas left over, but everything else doesn't have yes anymore.

305
00:49:56.550 --> 00:50:09.780
Catherine Zucker: But if you serve you so if you look you've looked at very, very young clusters i'm assuming as like analogs and and is the gas also very highly extended as well, so that that would be something to look for.

306
00:50:10.440 --> 00:50:17.040
Marina Kounkel: Well, in the Ryan Ryan, you do have a long filament but half of orion has already depleted gaps.

307
00:50:18.660 --> 00:50:19.050
Catherine Zucker: Okay.

308
00:50:20.340 --> 00:50:24.810
Catherine Zucker: All right, so we should talk a little bit more about that offline yep yep thanks.

309
00:50:27.900 --> 00:50:31.530
Morgan Elowe MacLeod: So I had a bit of a related question.

310
00:50:33.000 --> 00:50:39.030
Morgan Elowe MacLeod: We it's thinking a little bit about sort of the differentially rotating Frame of Reference so.

311
00:50:39.840 --> 00:50:55.920
Morgan Elowe MacLeod: You know I do either dynamic simulation something that we sometimes do is we put ourselves in that differentially rotating frame and we look at the time of evolution, so can we do that sort of analysis here and and ask like how the stretching stretch over time.

312
00:50:57.210 --> 00:50:57.840
Morgan Elowe MacLeod: Like.

313
00:50:58.950 --> 00:51:06.690
Morgan Elowe MacLeod: And how that traces these elementary structures and I was wondering, as we looked at sort of the in the age bins.

314
00:51:07.860 --> 00:51:16.050
Morgan Elowe MacLeod: Are there reasons why we might not find something film entry, that is a given year old, for example, and maybe like our their.

315
00:51:17.280 --> 00:51:22.050
Morgan Elowe MacLeod: selection is incorrect the right word but it's like is there are there properties of.

316
00:51:23.700 --> 00:51:39.360
Morgan Elowe MacLeod: These groupings that allow you know clump point like ones to persist for longer so that we still see them as groupings and string like things to stretch out over time so maybe you can talk a little bit about.

317
00:51:41.130 --> 00:51:42.990
Morgan Elowe MacLeod: How these evolved in the galactic field.

318
00:51:43.740 --> 00:51:45.030
Marina Kounkel: Sure, so the.

319
00:51:46.080 --> 00:52:07.500

Marina Kounkel: rotation is happening in this direction, or I remember, I think I think it's in this direction so as things are orbiting as this bit is going to be pulled less strongly or more friendly, and this, but so things are going to be start to if they are originally for me.

320
00:52:08.580 --> 00:52:14.130
Marina Kounkel: perpendicular to the spiral arms as and differential rotation with killed them eventually over time.

321
00:52:16.050 --> 00:52:33.120
Marina Kounkel: And, of course, there are title forces that are happening that are acting on the individual clusters and individual strengths and they they would disperse the populations further so title forces through you tend to develop that self titled sales.

322
00:52:34.260 --> 00:52:40.440
Marina Kounkel: Typically, by the age of 400 million years so it's these are a bit too young to really have.

323
00:52:41.700 --> 00:52:43.890
Marina Kounkel: experienced many of these tides.

324
00:52:45.900 --> 00:52:55.860
Marina Kounkel: But there have been some studies that are actually trying to find title tales around cluster such as it something nice so following those.

325
00:52:57.210 --> 00:52:58.770
Marina Kounkel: it's starting to become possible.

326
00:53:00.180 --> 00:53:04.920
Morgan Elowe MacLeod: yeah absolutely but like even as we look at the changing morphology is between you're very.

327
00:53:04.950 --> 00:53:06.150
Morgan Elowe MacLeod: Young groups.

328
00:53:06.150 --> 00:53:07.650
Morgan Elowe MacLeod: And you're older groups.

329
00:53:09.240 --> 00:53:18.540
Marina Kounkel: Yes, of interest changing ufology yes, for the most part as a galaxy completes one or but, for the most part the.

330
00:53:19.350 --> 00:53:32.370
Marina Kounkel: velocities of these more extended stars tend to be two different from the pit parental the velocity of the structure that would have would have been originally there, so they are no longer recoverable for clustering.

331
00:53:33.120 --> 00:53:44.490
Marina Kounkel: As we are able to determine more ages of stars, even if they are not necessarily part of the movie groups such as through through astrocytes seismology.

332
00:53:45.390 --> 00:54:00.690
Marina Kounkel: of geographic chronology then we perhaps might be able to reconstruct on the appalachians a bit more, and then see how exactly all the stars that have originally been part of our populations being dissolved into the galaxy.

333
00:54:02.280 --> 00:54:06.240
Morgan Elowe MacLeod: Fantastic to both of you Kevin Marina.

334
00:54:07.020 --> 00:54:07.920
Keivan Stassun: Can I can I.

335
00:54:08.130 --> 00:54:21.240
Keivan Stassun: Start leaning so Marina just because I know this is a question that you get often and in case any of the folks in the audience later and wondering this question to themselves, I thought, maybe i'd preemptively asked you the question.

336
00:54:22.440 --> 00:54:25.590
Keivan Stassun: You know, sometimes right in astronomy.

337
00:54:26.970 --> 00:54:30.420
Keivan Stassun: We see string like structures that are.

338
00:54:32.070 --> 00:54:42.000
Keivan Stassun: You know that are not real that are the results of of you know of errors and Neil projected along the line of sight and fingers of God type things, how do you know that that's not what you're saying.

339
00:54:42.870 --> 00:54:56.130
Marina Kounkel: i'm so us here in the local volume, we really have incredibly precise incredibly precise data somewhere at the.

340
00:54:58.200 --> 00:55:06.150
Marina Kounkel: Somewhere at the perseus on three areas arm, where you do have a bit more uncertainty in distance.

341
00:55:07.200 --> 00:55:07.830
Marina Kounkel: Then.

342
00:55:08.970 --> 00:55:22.080
Marina Kounkel: The exact orientation of the string may be a bit more up to the plate, but in the plane in the sky you wouldn't expect finger so oh God and it's a lie alone in plato's time.

343
00:55:24.420 --> 00:55:26.940
Keivan Stassun: Great Thank you thanks again.

344
00:55:28.050 --> 00:55:42.210
Morgan Elowe MacLeod: And to both of you, we have you know, a couple of minutes, whether your thoughts like where do we go from here, what are you most excited about next like to as a last word there's such richness here and so much to talk about but.

345
00:55:44.370 --> 00:55:45.420
Keivan Stassun: Marina you please.

346
00:55:45.660 --> 00:55:58.830
Marina Kounkel: yeah so right now we are in the process of starting spss five which is going to observe spectrum of millions of stars, and this will include the.

347
00:55:59.400 --> 00:56:10.950
Marina Kounkel: hundred thousand young stars and we already have been able to observe several thousands of them in just the first couple of months operations so as we are getting more retail velocities we.

348
00:56:11.700 --> 00:56:22.410
Marina Kounkel: are going to be as precise as a promotional guy provides we are able to explore the full face space and actually start looking at how these individual stuff wrong if we just have all our time.

349
00:56:23.040 --> 00:56:36.480
Morgan Elowe MacLeod: that's really beautiful that's really beautiful well on that note let's all express our gratitude to our speakers for joining us remotely this has been a really fascinating hour Thank you so much.

350
00:56:37.620 --> 00:56:39.690
Morgan Elowe MacLeod: And Thank you everyone for the great discussion.

351
00:56:41.490 --> 00:56:42.690
Keivan Stassun: thanks for the opportunity.

352
00:56:45.390 --> 00:56:45.750
Keivan Stassun: bye bye.

353
00:56:46.170 --> 00:56:47.940
Morgan Elowe MacLeod: bye it's really wonderful to have you.

354
00:56:48.660 --> 00:56:49.230
thanks again.