so our final talk this morning is going to be by Robert Pappalardo on revealing Europa's ocean and let me just say that Bob is a senior research scientist in the planetary science section of the Science Division of the Jet Propulsion Laboratory in Pasadena California that's the other PL the one on the west coast his research focuses on processes of shaped the icy satellites the outer solar system especially I wrote that in the rate of its probable subsurface ocean he's the Europa study scientists for the
development of future Europa mission

concepts and a member of the NRC's Space Studies board so ah

good morning as other speakers have already mentioned the evidence for a subsurface ocean at Europa is potentially profound Europa has the surface like no other in the solar system and its subsurface arguably offers the greatest likelihood for life beyond the earth in our solar system

let's take you back to 400 years ago when of course Galileo's observations of the Galilean satellites including Europa
helped to change our sense of place in

the cosmos there was another center of

motion out there which argued for her

neck kisses idea and Galileo observed

over subsequent nights saw all four

Galilean satellites revolving about

Jupiter and using the JPL solar sister

simulator we can reconstruct which ones

he saw in on that first night it looks

as though IO and Europa were grouped
together into apparently one little star

the first spacecraft image of Europa was

brought to us by the imaging photo

polarimeter on the pioneer 10 spacecraft
the only image of Europa from pioneer 10

44
00:02:35,800 --> 00:02:43,920
or 11 spacecraft principally a

45
00:02:38,319 --> 00:02:48,280
magnetometer mission and as Torrance

46
00:02:43,919 --> 00:02:49,419
reviewed we knew a little bit about you

47
00:02:48,280 --> 00:02:53,379
open the other satellites from

48
00:02:49,419 --> 00:02:55,629
telescopic observations we knew that the

49
00:02:53,379 --> 00:03:01,419
surface composition included water ice

50
00:02:55,629 --> 00:03:03,219
based on spectra we had some idea of the

51
00:03:01,419 --> 00:03:05,859
density though that information was

52
00:03:03,219 --> 00:03:08,349
improved by pioneer showing that Europa

53
00:03:05,860 --> 00:03:10,270
had a density of about three and rocky

54
00:03:08,349 --> 00:03:14,560
but less than I owe a little bit

55
00:03:10,270 --> 00:03:18,130
different from IO here's another fun

56
00:03:14,560 --> 00:03:21,159
every you can take the new JPL eyes

57
00:03:18,129 --> 00:03:23,229
on the solar system tool ride along with
the Pioneer spacecraft and at the right time at the right on the right date of December third 1973 looked toward Europa and zoom in and see the view that we had at 200 kilometers per pixel at the time of Europa's surface and it seems just like or analogous to Galileo who famously recorded Neptune without knowing it in January 1613 pioneer also spotted Neptune next to Europa through the 70s as torrance alluded to there was the thought that there might be oceans in some of the large satellites of the solar system and was John Lewis and his
student guy consumed on yo and then

Fraser finale who proposed from models of composition and radioactive decay that there might be oceans within these satellites and then in the late 70s and early 80's tidal heating was discussed as your way to maintain oceans though casa

minha peel and Reynolds wrote that convection might kick in and freeze a notion that is if a nice shell is thick enough then the ice might convict in the solid state like a lava lamp and that they thought would freeze up an ocean so
oceans came and went through this period

87
naturally with Steve Squyres in a paper

88
with cast and Peele Reynolds who said

89
well you know there might be enough

90
title heat if we push the parameters a

91
bit to maintain an ocean with in Europa

92
underneath a thin enough shell that it

93
won't affect that ocean could be there

94
still today and that was followed up by

95
og Congress and Stevenson are used a

96
more sophisticated model in 1989 to say

97
that yes it looked like there could be

98
sufficient heat to maintain an ocean

99
beneath a conductive I shell using a

100
more sophisticated model of tidal heating so that set the stage so that earlier works at the stage for Voyager which saw few large impact craters on the surface which suggested a very young surface surface or perhaps the larger craters were relaxing way as Mike Mahlon pointed out in the early 80s along the Terminator along the right-hand edge of that Voyager 2 image at the right that there is modeled terrain pits and domes along the terminator would those are those tiny craters and in fact is the surface very old the bright lineata plain suggested crystal mobility it was
shank and safer it back in nineteen eighty who looked at the Voyager images and said you know there are dark bands that could fit back together with the bright pieces moving back into place like puzzle pieces but it was nearly a decade before shanks then controversial idea of crustal mobility was published right around the time of Jocasta Stephenson said you know it's possible to maintain an ocean so a Voyager 1 of course had relatively poor resolution at Europa 20 kilometers per pixel still 10 times better than why
near did and Voyager 2 at ten times
better than that two kilometers for
pixel but it would remain for Galileo to
really greatly increase our knowledge of
Europe through imaging another other
techniques there were as torrents looter
212 prime mission closest approach flies
three were usable close Europa flybys
and then there was the Galileo Europa
mission because Europe was turning out
to be so exciting that an extended
mission would focus on Europa with
cooking eight close approach flybys of
Europa excuse me that one of those was gravity only and two of them ended in radiation-induced upsets of the spacecraft so really with 5 close approach additional postage provide lies we were able to learn amazing things about it Europa of course it is about the people i had the pleasure to work with this motley crew as an affiliate of the galileo imaging team mike pelton in front you can recognize let's see tour enjoy your hat today there is on the on the right clark chapman in front with greenberg in the back right along
greeley in the back organizing the crew

00:08:46,870 --> 00:08:52,948
a bit Jim head in the back left

00:08:50,278 --> 00:09:00,838
we've been having fun on Facebook salad

00:08:52,948 --> 00:09:03,688
I found this photo of tagging away the

00:09:00,839 --> 00:09:06,779
first images from Galileo of Europe were

00:09:03,688 --> 00:09:08,639
only slightly better than geometric

00:09:06,778 --> 00:09:11,220
resolution than Voyager 2 images they're

00:09:08,639 --> 00:09:14,938
1.6 kilometers per pixel but the much

00:09:11,220 --> 00:09:18,769
better camera a solid-state imager was

00:09:14,938 --> 00:09:22,078
able to get much higher quality images

00:09:18,769 --> 00:09:26,970
and here the surface shown in false

00:09:22,078 --> 00:09:30,899
color as compiled by Paul Geisler at the

00:09:26,970 --> 00:09:33,569
time and what we saw is is the the right

00:09:30,899 --> 00:09:36,899
hand side is littered with some of these

00:09:33,568 --> 00:09:39,748
pits that we were getting a feel from
from Voyager and both Clark Chapman and I looked at the size distributions of these pits and said you know they're all kind of the same size are all turning out to be several to attend little lesson 10 kilometers across which suggested maybe they're not impact craters maybe they're endogenic features related to internal activity there were these spots littering the surface the dark spots and they also seem to be about the same size maybe they're somehow related is it related to some sort of internal volcanism or other
activity it we found that the surface was brightening with age older features were brighter the idea of non synchronous rotation had come up from Voyager days and based on this color composite Paul Geisler argued for non synchronous rotation when we looked at the age of lineaments there seems to be a rotation of lineaments through time as well consistent with the icy shell moving independent from the interior slightly faster than interior as if lubricated decoupled from the interior by a subsurface ocean there were a
series of papers published based on some of the first images arguing for crustal mobility non sink

this rotation and this picture from the same sequence was on the cover of the New York Times arguing for crustal mobility so Shank and MacKinnon it seemed were right the puzzle pieces for fitting back together this is Europa's surface as it looks stretched out into a global map as we know it today very few impact craters there's one here this bright one will work if you're Welsh there are only about a dozen or so that
one can recognize and from observations of impactors in the Jovian system we no

one should hit every three or four million years so you do the calculation

that comes up that Europe is average surface ages about 60 million years

Europa has been repaved since dinosaurs roamed the earth we don't know whether that was in a spurt 50 or 60 million years ago or if it's a continuous process and is ongoing today but why

would you wrote but died out just 50 or 60 million years ago in fact it's probably either an ongoing process where

Europa may go through cyclical activity
predictions of tidal heating as tied to

IO suggest that IO is pulling Europa back and forth and increasing its eccentricity and decreasing it again on a time scale of 10 to the sixth years or

so here's what those ridged planes look like close up those monuments are ridges not just single ridges but double ridges crisscrossing the surface it looks like generations of ridge upon which your sets of ridges have created those Ridge planes and then there's that model terrain where those pits and spots are some show chaotic chaotic terrain look
looks a little like hamburger in that

Ridge Plains has just crumbled in place to form that chaotic train

now I'm a geologist and so we were working to understand whether the surface geology told us about an ocean

but it was the magnetometer team if anyone has discovered an ocean it was them who through measurement of an induced magnetic field at Europa found strong evidence that Europa is acting as a conductor that Jupiter's external field is inducing a magnetic field in Europa and that's that remains the
strongest evidence for subsurface ocean

at Europa today that so exists today

and of course the gravity data through

measurement of the entrance of the

moment of inertia tells us that Europa

is almost certainly differentiated with

an iron core or rocky mantle and then an

h2o layer something like a hundred

kilometers thick as the illustration

from michael carroll of europa in

Jupiter's immense magnetosphere and an

illustration of that induced magnetic

field at Europa recall that Europa is

bathed in high-energy plasma charged

8
particles within it with kill electron

vil and mega electron volt energies are

slamming into your oppa at all times and

while that is a nasty environment and

would kill a person in 15 or 20 minutes

if exposed to it is potentially life

nurturing because when high-energy

particles slam into h2o they make H and

they make oh and some of those things

recombine and Yuri combined with the

other contaminants on the surface and

they make things like peroxides and

formaldehyde and o2 Europa doesn't have

much of an atmosphere a Pico bar 10-12

hours but it does have essentially an
atmosphere frozen into its surface there

is O2 at that surface if all of Europa’s oxidants could be dumped into its suspected subsurface ocean then that ocean be more oxygenated than is Earth’s ocean and that could serve as a fuel for life we need to understand the processes of whether that material from the surface gets into the ocean and how here’s what the surface looks like a bit closer up sorry no scale bar here but again these these spots or something like seven kilometers across and ridges are
commonly a couple 25 kilometers across

some of them are quite bizarre seeming
to bounce across the surface in a

cycloidal pattern not something used to

seeing on a planetary body okay I'm

the story of Europa's Regis is

interesting because there are many Ridge

models that have been proposed and while

they are the most ubiquitous ubiquitous

feature on a surface they are the most

controversial as well is the surface the

ice shell being cut completely through

and tidal flexing opening and closing
ridges a model that has been supported
by Rick Greenberg and colleagues or are
there other models that might involve
solid state ice and it's almost incidental that the ocean is below
enabling large-scale tidal flexing and
one model illustrated is right is the idea of shear heating that
back-and-forth motion created by tidal flexing is what is heating a plane in
the subsurface and and warming that ice
and pushing the surface up to form a ridge and interesting in the sense of the story of Galileo and
Europa exploration this these models

somewhat led to a schism of is Europa's ice shelf in or as Europa I shall thick

Torrance likes to call it the pizza
debate is it thin crust or thick crust

and we working some of the ridge ideas

and Rick Greenberg pointed out that was developing this model and I pointed out that well this model couldn't work if the ice shell had to be less than about seven kilometers thick to cut all the way through and the tidal heating models were suggesting a thicker shell in his response was then the I
shall must be thin and so he ran with

that rather than questioning the model whereas in a thicker shell model

the ice shell can be pierced down to a ductile layer and pulled apart atop warm

flowing glacial ice and that's the model

illustrate at the bottom right four bands on Europa we were able to zoom in

on some of these wedge-shaped bands that Shang cam mackinnon had originally investigated and and again the puzzle

pieces of each side fit back together

perfectly and the center is striated

analogous to what we see at the
mid-ocean ridges at spreading centers on the earth and then in a thick thin debate it was is that a top warm ice or is that atop liquid water impact craters as zippy turtle and Betsy prot so argued like will argue for a nice shell that's relatively thick at least eight kilometers thick or you wouldn't get a nice crater morphology and later Paul Shank wrote on these multi ring structures there only two and he invoked a model that had been developed for Ganymede and Callisto that says if we penetrate through the ice shell to a
fluid layer then the crater fills in

this large crater essentially fills in very rapidly pulling the brittle ice along inward with it to form these concentric rings and based on the scale about 40 kilometers across for the inferred crater he said well then they penetrated to about 22 liquid water at about 20 kilometers depth consistent with the title heating models in terms of surface composition as a question of what this dark reddish stuff is that we see and based on infrared spectra leading candidates are sulfate
salts or sulfuric acid hydrate and in reality it's probably a combination of those two so is Europa's ocean like Epsom salt or battery acid the answer is more likely that it's like Epsom salt but that the battery acid is created at the surface by irradiation of the surface here are some of those freckles lenticular is the Latin for them that's that when we saw them first rang a bell with me as what I had heard about that Reynolds and Casson model way back when that convection may have kicked in in the ice shell and perhaps what we're seeing is the tops of die appears warm
ice blobs that have risen up through Europa's ice shell again implying that it would be more than 20 or so kilometers thick and the bottom is showing a model by Amy bar of that warm flowing ice all the red being only about 30 Celsius below below zero in terms of the temperature warm ice even though the surface is a 100 Kelvin that warm convecting ice would be to 40 or so Kelvin and illustration of the lava lamp like model of Europa's subsurface conviction some of the most fascinating terrain or
care starting to get up some of the most fascinating train is this chaotic terrain and in the thicker thick model thin or thick model the issue was as Europa's ice shell melted out completely or have blobs of warm ice risen and and moved to the blocks above like in a mosh pit and recently Brittany Schmidt has suggested an interesting hybrid model that chaos may form above a melt zone in a thick ice shell that essentially we're looking at areas that used to have lakes beneath them the size of one of the US Great Lakes and that some of these
regions may still have lakes beneath them today and so the discussion continues as to whether we're actually looking at floating icebergs and here just for utorrent the Titanic is about 270 meters from stem to stem so Europa may have the ingredients for life in terms of water more than two times all of the Earth's oceans in terms of the essential elements from its formation and from impacts bringing carbon and other elements it may have chemical energy from above oxidants created the surface by irradiation and potentially
energy from below if the mantle is warm

if it is tidally heated then there could be black smoker like activity pouring reductants into the base of the ocean and it's probably a relatively stable environment somewhat variable but simmering for four billion years so that leads to basic questions about the ocean its existence its extent its salinity about it the ice shell the existence nature of water within and beneath the nature of this surface ice ocean exchange composition the distribution and chemistry of key compounds the links to ocean composition
in the geology what are the characteristics formation of surface features including sites of recent or current activity and these all relate to that overarching theme of Europa's potential habitability the history of trying to develop the next mission to explore Europa from the late 1990s could be a talk in itself but I'll simply say that the latest iteration is a very feasible one that could cost about two billion dollars short of launch vehicle would address these ocean I shell composition geology objectives and could
have a reconnaissance camera as well to

set the stage for future Lander it would

do several dozen close flybys of Europa

to understand the nature of its ocean

and understand its habitability

potential habitability and just to

finish there are important fundamental

questions remaining to answer in our

solar system especially with regard to

its its potential for life beyond Earth

its origins and it's and it's common

asst it was 400 years ago the Galileo

the gala that Galileo's observations of

the Galilean satellites changed the
human perspective on our place in the

universe and it's fascinating to think

that one of those worlds could in the

future change it again thank you very

much

it's tough to explore it talk about an

entire world in 20 minutes I'll tell you

what why don't we go ahead and assemble

the panel and so let you take a seat

Torrance and Arturo if you can come on

up and you have a question for Bob why

don't you try to get first in line but

we will see ah please go ahead

I don't see speaker Oh 40 barrels you


mentioned about some kind of the

00:25:30,569 --> 00:25:38,549
variations in the mutual position of the

00:25:33,240 --> 00:25:41,430
say Europa and I oh you know and in in

00:25:38,549 --> 00:25:47,430
addition to the regular change so are

00:25:41,430 --> 00:25:51,090
these deviations mostly just produced by

00:25:47,430 --> 00:25:53,820
the Laplace resonance I mean within

00:25:51,089 --> 00:25:57,379
Laplace resonance or it's some kind

00:25:53,819 --> 00:26:01,079
additional mechanism exists and how deep

00:25:57,380 --> 00:26:04,050
such fluctuations are whether they

00:26:01,079 --> 00:26:08,279
influence on the death of the ocean or

00:26:04,049 --> 00:26:11,960
only on the temperature so the idea

00:26:08,279 --> 00:26:16,109
that's been developed is that x io

00:26:11,960 --> 00:26:19,079
heating up it could heat to the extent

00:26:16,109 --> 00:26:21,990
that its ability to dissipate heat

00:26:19,079 --> 00:26:24,119
actually decreases and to conserve
angular momentum that will actually end up changing slightly its orbital eccentricity and it will drag your OPA alone as it does so and recent models have suggested Europa's ice shell thickness could fluctuate from something like 10 or 15 kilometers up to something like 30 kilometers so it's possible Europa may have even experienced a thin shell like history and I think thick shell like history and that that may vary on something like a 10 to six year cycle to about ten to the six years is in the models but the models can be
tuned there a lot of parameters so yes

thank you John Sarkissian from CSIRO

Australia's for question 4 torrance um

we've heard about how the spacecraft get to the planets and and they're able to image them and so on but very little has

been said about how that information is actually returned times would you like to say a few words about the the Deep Space Network involvement in in those outer planet our missions communications

is obviously a critical element in all these things and it often operates beneath everybody's visibility level
it's just something that happens as a

scientist I just regard that as part of

the magic because I can't figure out how

we get all those bits back from a health

fair and I know John that I talked with

you the other day walking over and then

I realized reading your bio that you are

one of the people who were parks

facility in Australia that helped bail

us out when our communications system

became a little flaky on Galileo and

it's a marvelous story in itself how

d codes

cooperation amongst the various

...
institutions and radio tracking

00:28:18,819 --> 00:28:27,970
facilities around the world go you're

00:28:21,278 --> 00:28:31,690
quite right to bring that up Heidi this

00:28:27,970 --> 00:28:34,360
is for torrents will hear from Chaz

00:28:31,690 --> 00:28:36,308
tomorrow how most about the exoplanets

00:28:34,359 --> 00:28:39,908
and the Kepler spacecraft is showing

00:28:36,308 --> 00:28:42,788
that most many thousands of candidates

00:28:39,909 --> 00:28:45,700
are Uranus and Neptune sighs bodies and

00:28:42,788 --> 00:28:48,548
yet the only mission that has ever gone

00:28:45,700 --> 00:28:51,308
to a nice giant was launched before I

00:28:48,548 --> 00:28:53,888
even graduated from high school and now

00:28:51,308 --> 00:28:55,750
I got gray hair and you've already

00:28:53,888 --> 00:29:00,609
pointed out that we're looking at a

00:28:55,750 --> 00:29:02,409
radio dark outer solar system now what's

00:29:00,609 --> 00:29:05,888
your thoughts from a historical
571 00:29:02,409 --> 00:29:07,929 perspective of how that got lost from
572 00:29:05,888 --> 00:29:10,329 the Jupiter orbiter and the Cassini
573 00:29:07,929 --> 00:29:13,960 Saturn orbiter and why did it get lost
574 00:29:10,329 --> 00:29:16,148 that we don't have an outer sister solar
575 00:29:13,960 --> 00:29:18,519 outer planet orbiter what happened and
576 00:29:16,148 --> 00:29:19,479 what's the lesson learned so we can fix
577 00:29:18,519 --> 00:29:21,599 it I think
578 00:29:19,480 --> 00:29:25,210 I think the discussions yesterday
579 00:29:21,599 --> 00:29:27,159 Illustrated how cyclical the funding for
580 00:29:25,210 --> 00:29:30,789 this entire enterprise is not just outer
581 00:29:27,160 --> 00:29:32,560 planet exploration it's it's not
582 00:29:30,789 --> 00:29:35,139 something that's taken for granted at
583 00:29:32,559 --> 00:29:36,750 the political level it's something that
584 00:29:35,140 --> 00:29:40,720 we have to continually make the
arguments far I would just remark from a historical point of view we were well served by jumping on top of the Grand Tour alignment I mean that for the outer planet exploration because that actually got us some data and remarkably short times it's not going to happen again for a while unless we get warp drive so I think they we have not lost the drive to do these things but they are still struggling with the generational nature of how long it takes to do them I agree with you there thanks Jennifer Tennessee Princeton University it's such a that
was a great question of course it's
interesting to note that the
generational moment corresponds to when
a lot of attention has been placed on
Mars as opposed to how long it takes for
satellites to get the honor system I was
really struck by the presentations which
looked like we're talking about planets
and moons and institutions but we're
also really talking about some important
relationships that made those systems
work and I'm struck by the number of
times we've seen you know that the
Torrance's participated in several
generations of missions or Paul shanks

00:30:48,160 --> 00:30:51,340
name coming up over and over again are

00:30:49,750 --> 00:30:54,160
these strong relationships between NASA

00:30:51,339 --> 00:30:55,869
and ISA then enabled and something like

00:30:54,160 --> 00:30:58,570
acini hogan's to be the success that it

00:30:55,869 --> 00:31:00,279
is and I think I like many people in

00:30:58,569 --> 00:31:02,259
this room have been very dismayed or

00:31:00,279 --> 00:31:03,970
distress at the cancellations of some of

00:31:02,259 --> 00:31:06,549
the larger scale international

00:31:03,970 --> 00:31:09,160
collaborations between NASA and nasa

00:31:06,549 --> 00:31:12,309
specifically whether it's exomars or the

00:31:09,160 --> 00:31:14,560
potential of a joint mission to your to

00:31:12,309 --> 00:31:15,730
Jupiter's moons but I'm wondering if the

00:31:14,559 --> 00:31:18,250
three of you could speak from your

00:31:15,730 --> 00:31:20,799
experience as to what are the parameters
for success for building the kinds of

strong relationships whether it's across

institutions or cross missions or across

continents

that enable these kinds of missions to

go forward let me just make a

preliminary I comment on that and then

ask my colleagues is it I have

frequently tried to make the point when

speaking to media that we got the wrong

name on our program by allowing it we

call unmanned or robotic it is

profoundly human and the crew of the

space craft are right here on earth and
in the command center and now with social media and other things we can bring the rest of the population of the world together with that that's been an evolving picture and that's true in the science community but there's a broader context to it in planning these next missions and looking toward future missions there was no meeting several years ago working with many of the same members of science definition team been working with for for many years when came to the realization it's about the journey that we have to be enjoying
ourselves along the way and working with good people too who have that very long-term vision and I think those who are dedicated to that future exploration work so well together because they have that long-term common goal and I'm not much to add what I said but I think first of all you have to consider that space science is not a scientific discipline is a complex a set of very different scientific disciplines and so there are always competition and cooperation aspects with play a role in
this in this field secondary even given

00:33:36,839 --> 00:33:42,599

the scientific disciplines that we call

00:33:39,148 --> 00:33:45,768

space science space science is not only

00:33:42,599 --> 00:33:50,759

science they need technological means

00:33:45,769 --> 00:34:00,629

rockets spacecraft communication

00:33:50,759 --> 00:33:56,819

networks political decisions huge

00:33:53,669 --> 00:34:00,629

amounts of money so is not only science

00:33:56,819 --> 00:34:04,519

and not even is not science is not even

00:34:00,628 --> 00:34:09,750

the most important driving force behind

00:34:04,519 --> 00:34:12,210

space science third the most challenging

00:34:09,750 --> 00:34:15,960

and important scientific mission space

00:34:12,210 --> 00:34:18,449

have to be done in collaboration big

00:34:15,960 --> 00:34:21,588

collaborations more collaborations just

00:34:18,449 --> 00:34:25,199

having a launcher is a collaboration

00:34:21,588 --> 00:34:27,659

having the Deep Space Network for ISA is
essential if you want to go into the
outer system outer solar system you need
an RTG generation you cannot have this
in Europe so that the man's in any case
and kind of collaboration and all of
this implies scientific personal
relationships but also complex political
and economical negotiations so the
situation is always very fluid
the difference in the budget system at
in Europe and in NASA has been the major
stumbling blocks in
in many in several cases and was a
source of not less important
controversies in some cases we know that

professor Russo pointed out the

detentions in the relationships between

Issa and NASA particularly what amazed

me was that the relationships survived I

wasn't certain when we started talking

on Cassini whether my European

colleagues even talked to us after what

the United States had done with respect

Ulysses program and it was personal

relationships that allowed people to say

hey you know there's a bigger picture

here we have to work together on this

we're not going to be able to accomplish
these things let's take one final

question let me pick up on that theme

actually because that's my question ask

the striking difference between what

Professor Russo describing what Bob has

recently experienced in the construction

of an international program for outer

planet exploration it seems now as a

result we're in a phase where US and

Europe are going apart and planning

their programs independently not just

the outer planets but it Mars too it

seems as we heard earlier what's the

impact of the current situation on this
with the respect to the future outer

00:36:30,650 --> 00:36:37,030
planet exploration start with

00:36:38,039 --> 00:36:47,039
the europa ganymede discussion and maybe

00:36:43,530 --> 00:36:51,090
others can pick up but we've certainly

00:36:47,039 --> 00:36:55,380
so when so we were working together as

00:36:51,090 --> 00:36:57,660
one wonderful group when us said okay

00:36:55,380 --> 00:37:00,900
we're not doing europa europe said well

00:36:57,659 --> 00:37:05,369
we are doing this Ganymede mission which

00:37:00,900 --> 00:37:09,300
has become juice and again the personal

00:37:05,369 --> 00:37:12,179
relationships continue we certainly want

00:37:09,300 --> 00:37:14,460
to work together with our colleagues in

00:37:12,179 --> 00:37:17,909
europe to explore the Jupiter system

00:37:14,460 --> 00:37:21,990
there will be us participation in the

00:37:17,909 --> 00:37:26,099
juice mission and we're doing all we can

00:37:21,989 --> 00:37:29,429
on our side to try to keep alive that
vision and resurrect a Europa mission

for the exploration of Europa and the Jupiter system good and Ganymede as a whole but without the u.s. participation

we will have we will continue to have tantalizing hints of what Europa is like but we won't have answers and my fear is that 50 years from now when we do explore Europa and we get a lander to the surface and we sample that stuff I fear as will say why didn't we do this 50 years ago because it's it could be that important all right let's thank our panel once more
and you may blame the moderator for cutting out seven minutes of your lunch no no quite the contrary thank you or off you did a fine job and thanks to the panel for such a stimulating discussion couple quick announcements before we break if you haven't already done so please take the opportunity to avail yourself of the oral history recording crew they're not down at this end today they're down at this end when you go out it will be to your left we've got a lot of experience and talent in this room and let's let's share that as much as we
can with the public in with the next generation we will be reconvening at one o'clock will keep an eye on the minutes won't hurt us but we do need to be back at one and lastly please remember the mission to take a buddy to lunch again the advantage of having us all here physically in one place is the interpersonal interaction interaction and lunchtime is a great time for that so without further ado see you back at one