

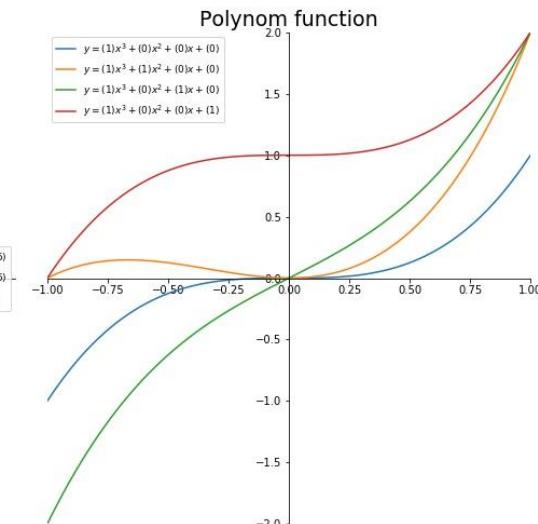
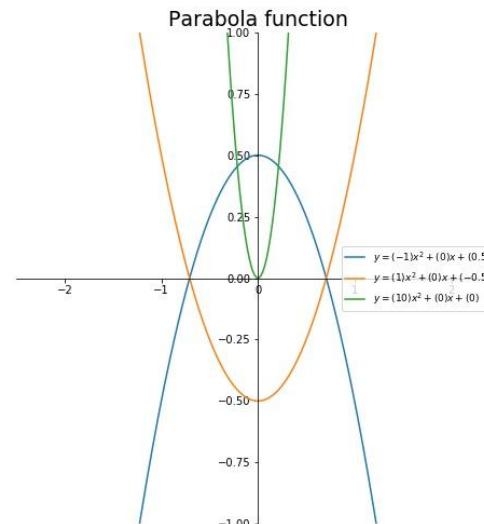
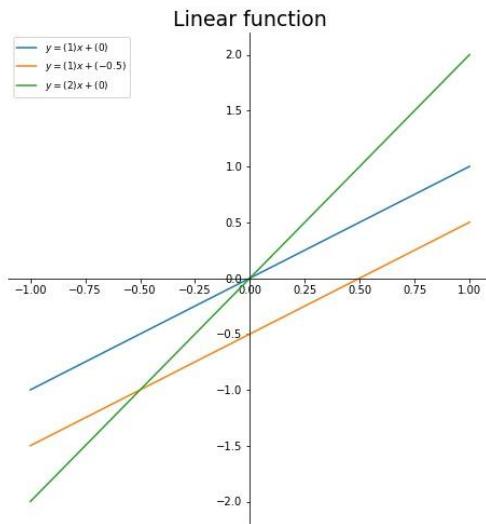


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Visualization: to make the invisible visible.

Dr. Arman Khalatyan
Leibniz-Institut für Astrophysik Potsdam (AIP)

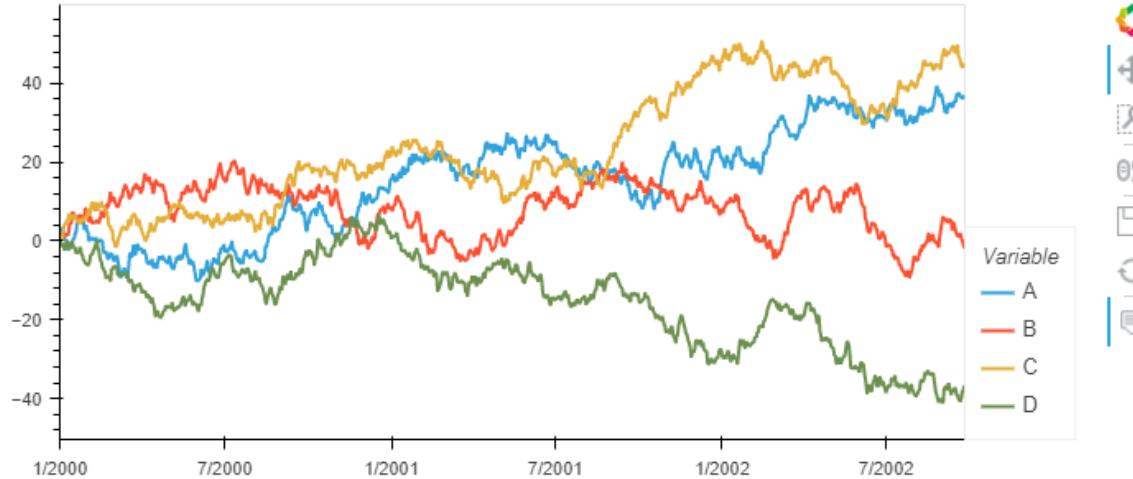
Line Plots



Interactive plots

```
import pandas as pd, numpy as np
idx = pd.date_range('1/1/2000', periods=1000)
df = pd.DataFrame(np.random.randn(1000, 4), index=idx, columns=list('ABCD')).cumsum()

import hvplot.pandas # noqa
df.hvplot()
```



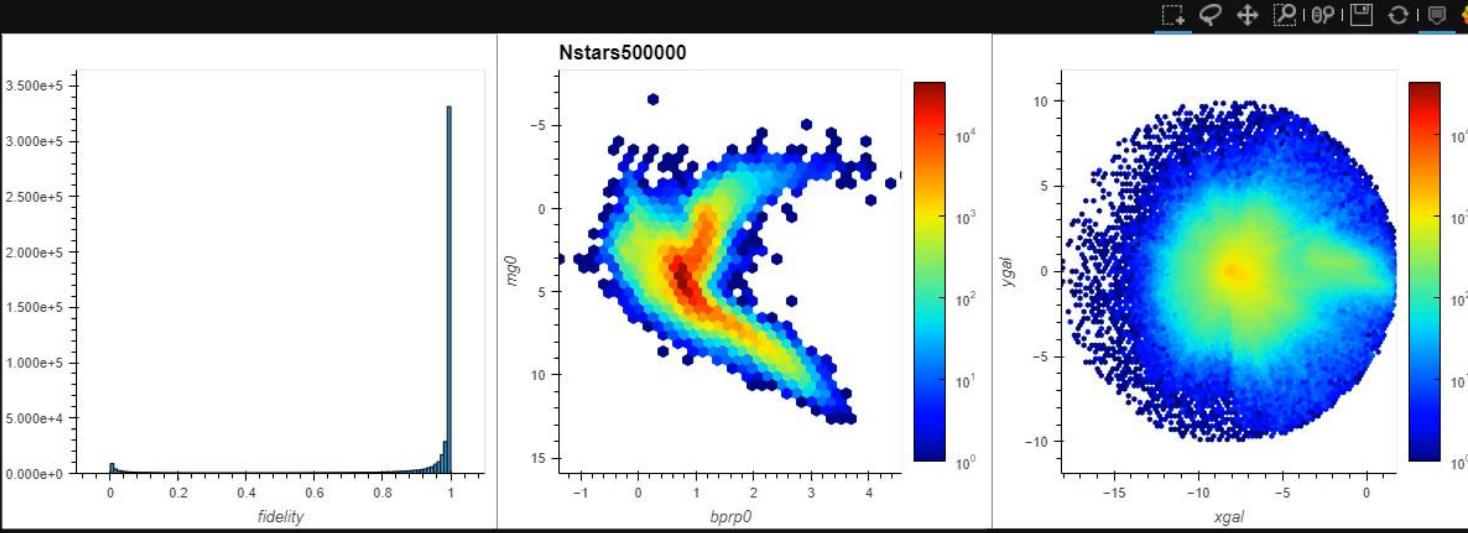
Jupyter notebook: dask+parquet+pandas+pyviz on **binder**

```
0000 rows × 9 columns

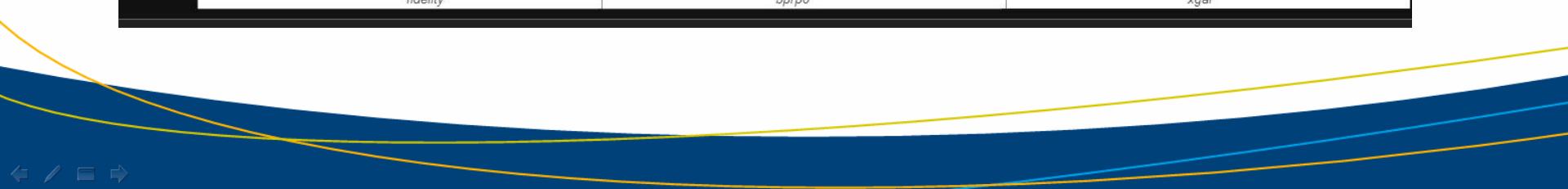
port dask.dataframe as dd
f=dd.from_pandas(df,npartitions=4).persist()

from holoviews.selection import link_selections
df.hvplot.hexbin("bprp0","mg0", groupby=[], height=400, width=400, flip_yaxis=True, logz=True, gridsize=40, aggregator="count", cmap='jet', cnorm="log", title=f"Nstars{l}" )#, datashade=True
l=df.hvplot.hexbin("xgal","ygal", groupby=[], height=400, width=400, cnorm="log", cmap='jet', gridsize=100 )#datashade=True,
d=df.hvplot.hist('fidelity',bins=100,height=400, width=400)

link_selections(fid*cmd + gal)
link_selections
id
```



The figure displays three plots generated using the hvplot library. The first plot is a histogram of the 'fidelity' column, showing a sharp peak at 1.0 with a maximum value of approximately 3.5e5. The second plot is a hexbin heatmap of the 'bprp0' and 'mg0' columns, with a color scale ranging from 10^0 (blue) to 10^4 (red). The third plot is a scatter plot of 'xgal' versus 'ygal', also with a color scale from 10^0 to 10^4 . All plots include logarithmic color normalization.

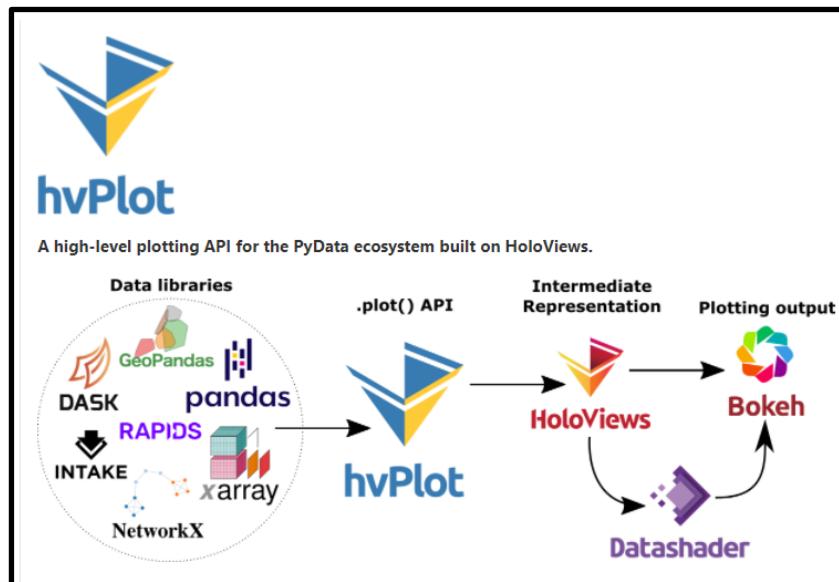




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Software ecosystem

- <https://hvplot.holoviz.org/>



```
pd.options.plotting.backend = 'holoviews'
```

```
conda install -c pyviz hvplot
```

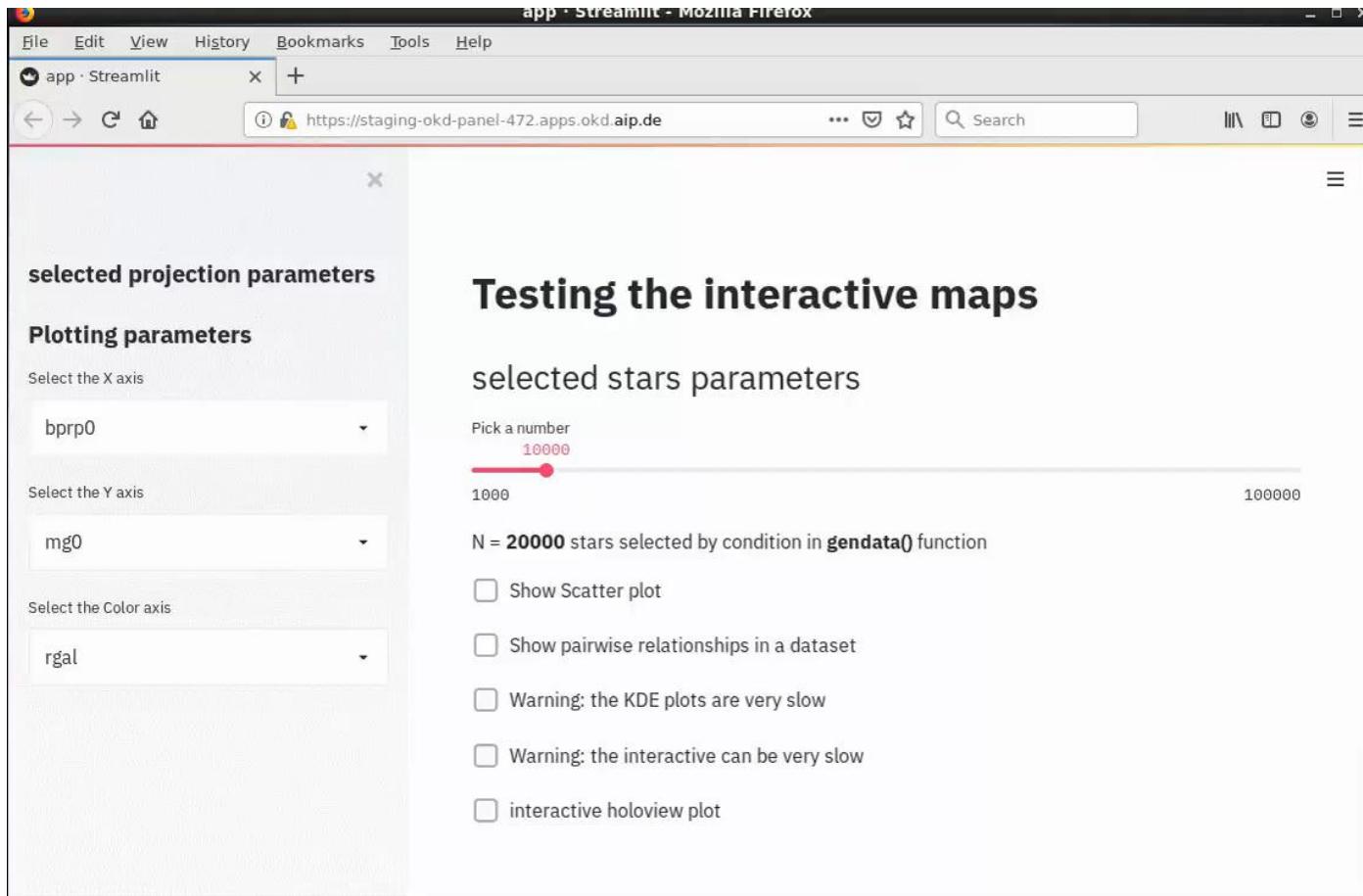
or using PyPI:

```
pip install hvplot
```

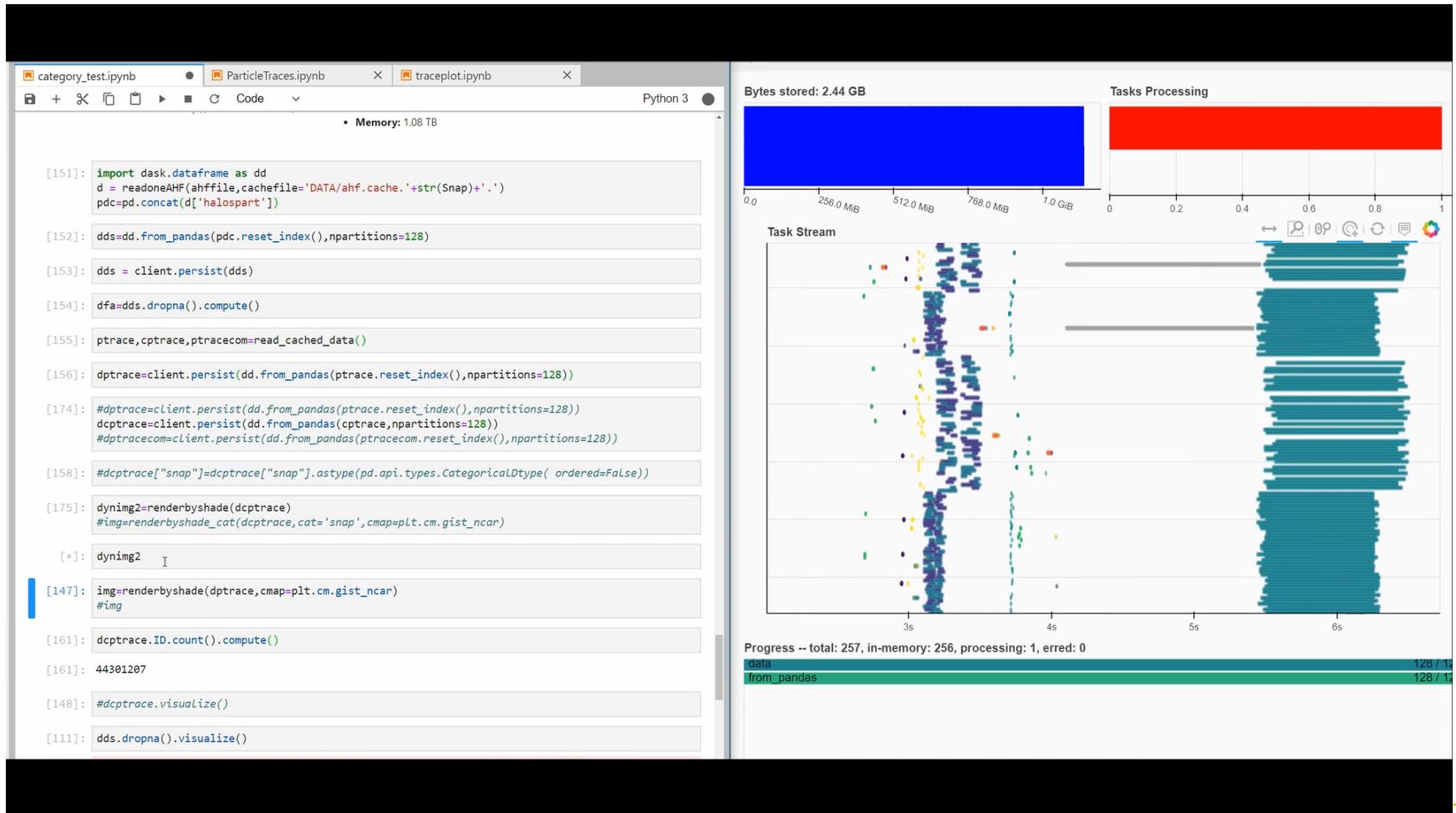
For versions of `jupyterlab>=3.0` the necessary extension is automatic. For versions of `jupyterlab<3.0` you must also manually install the JupyterLab extension:

```
conda install jupyterlab  
jupyter labextension install @pyviz/jupyterlab_pyviz
```

Streamlit: hvplot+StarHorse data

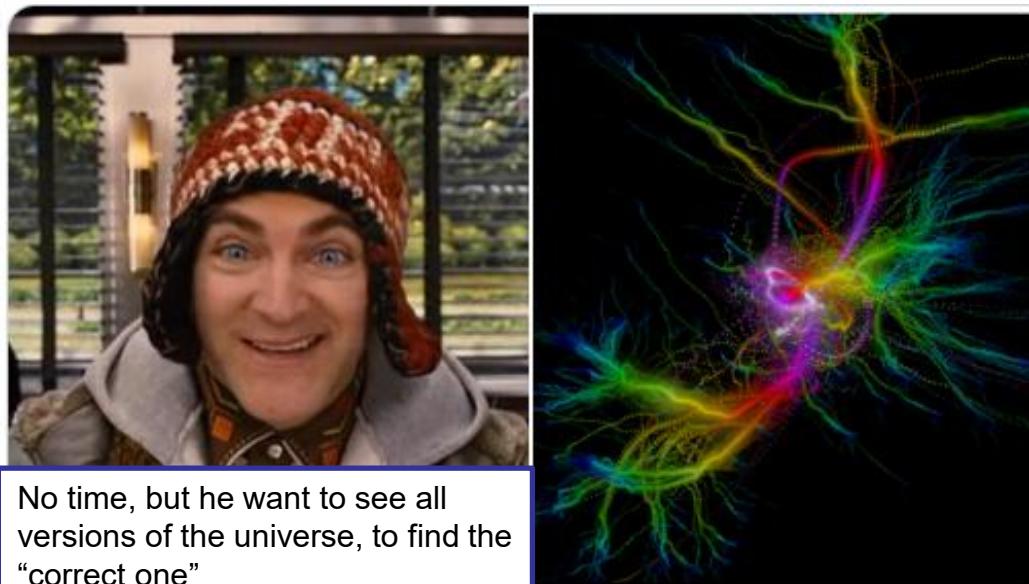


500 000 000 Gas particles on 128cores 1TB RAM



What cosmologists want?

Around **6:00PM**: “show me all models next to each others?.. Oh wait rotate there... zoom...mmm..
Show side by side, no-no, zoom out, but wait I have bigger simulation could you show that one?
Nice! Can I take the movie with me? Tomorrow at **9:00am** is my talk?”

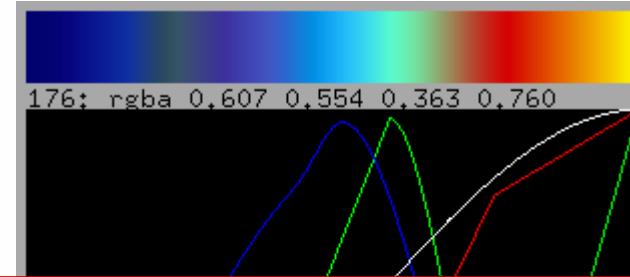


Breaking down the wishes

- Simulations
 - Dark Matter?
 - Gas/Dust?
 - Time, Trajectory?
- Observations
 - Multicolumn Tables
 - Stars/Colors/Spectra?
 - 2D images
 - 3D volumes

Rendering

- **Points: dots, Splats**
- Lines: pipes
- 3D shaded surfaces



Transfer functions are crucial
RGBA

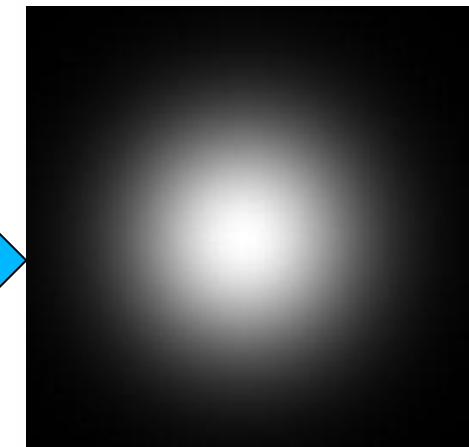
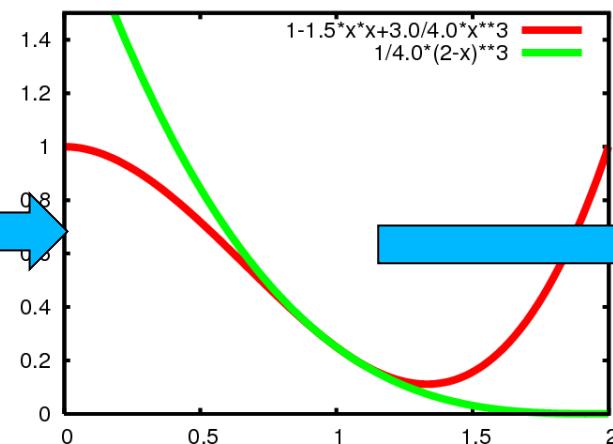
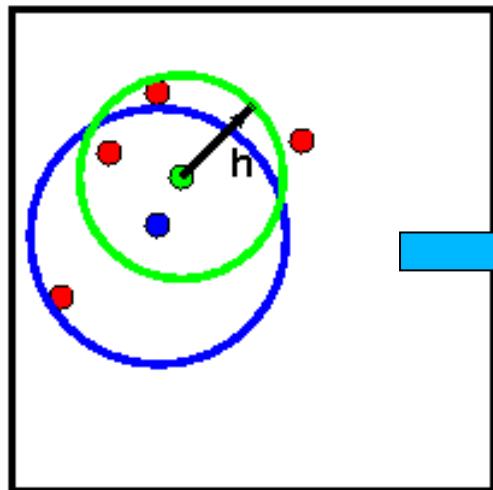




SPH method

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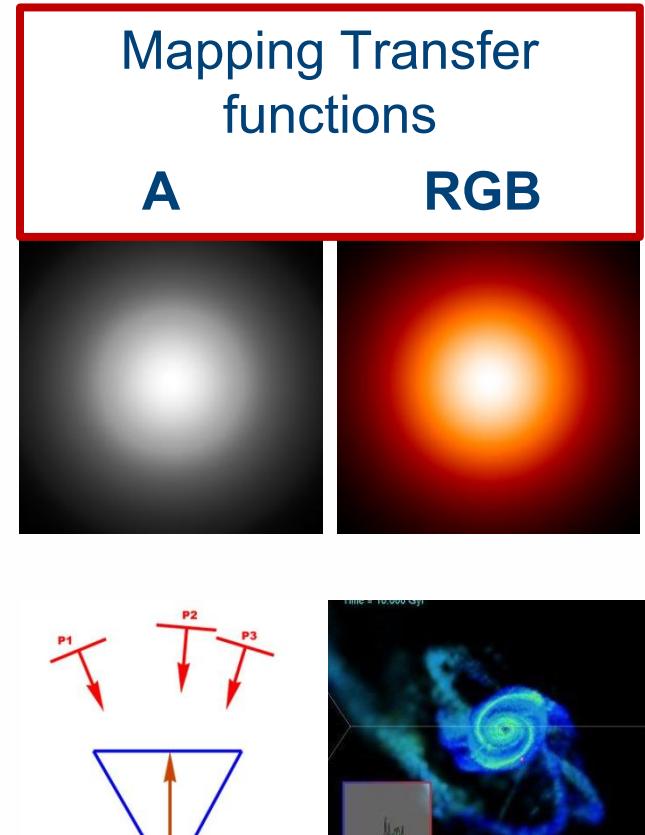
Assign "radius" defined by N-neighbors 30-60



PMViewer:

<http://pmviewer.sourceforge.net/>

- Minimalistic
“GameEngine”(2004)
- Camera:
 - 3D Stereo
 - 360VR
- Supported formats:
 - Gadget2
- Lang: C++,OpenGL GLSL,
MacOS,Linux,Windows
- Simulations:
 - $(x,y,z)+T$,
 - Rho,Tmp
 - 1vector + 1 scalar value is easy
 - Points, Lines, sphere



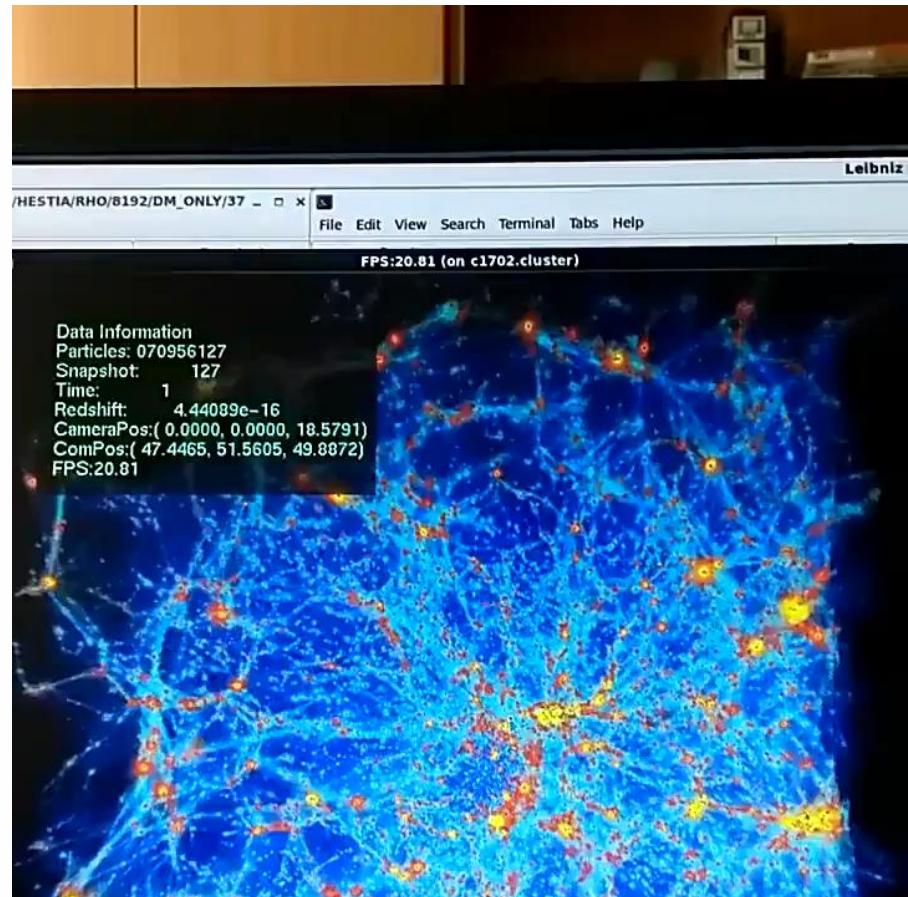


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PMViewer:performance



- Xp GPU RAM 16GB
 - 70MLN ~25fps
- T4 GPU RAM 24GB
 - 150MLN 30fps



<https://vr.aip.de>

2017 –
VR360!

2004 – 3D



2016 - Hologalaxy



Information

Referent

Kino

Slides

Physik

Besuchergruppen

Galaxy to go

VIP

Ins
Universum

Koop. (Planetarium/Uni)

interaktiv

online

vor Ort / AIP

Fester Raum

Mobil

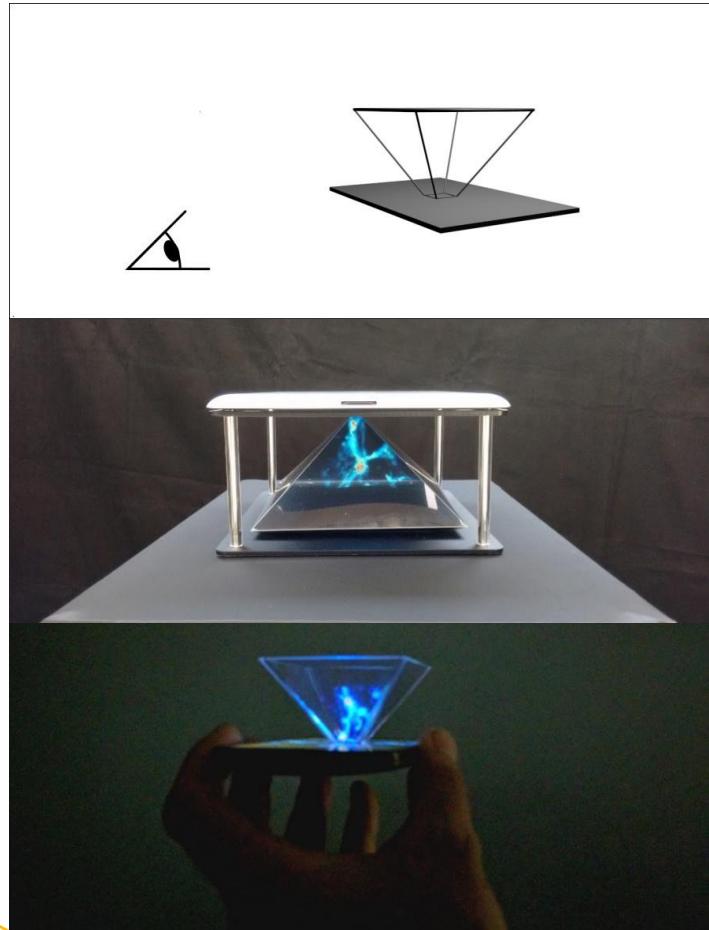
Giveaways... as a public outreach

Ballons im
Nachthimmel
über dem
Brandenburger
Tor.
© dpa(2015)



HoloGalaxies@AIP

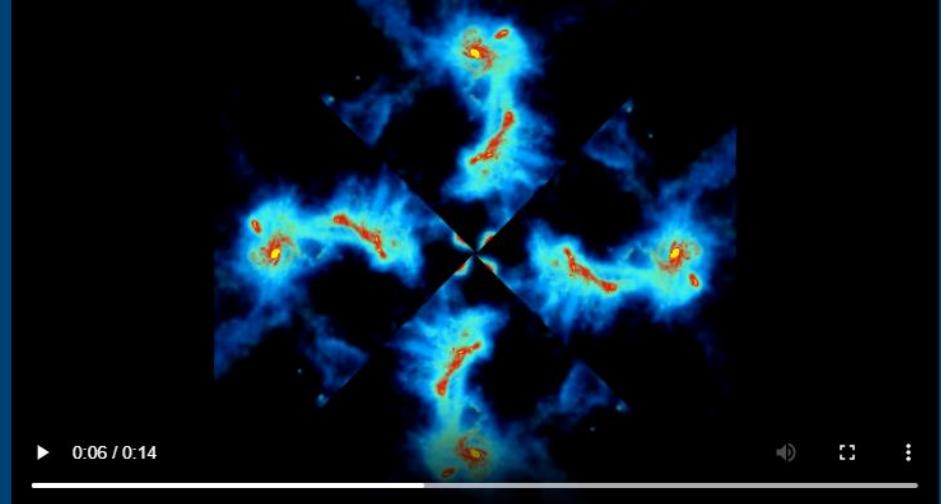
<https://escience.aip.de/vis/hologalaxy>



Study galaxies yourself – also as a hologram

Show random galaxy 

Normal Hologram Code: 0900-0



Dargestellt ist die Gasdichte in der Galaxie.

VR time

- Astronomer + 360camera = vr.aip.de
- pmviewer+6x90FOV snapshots

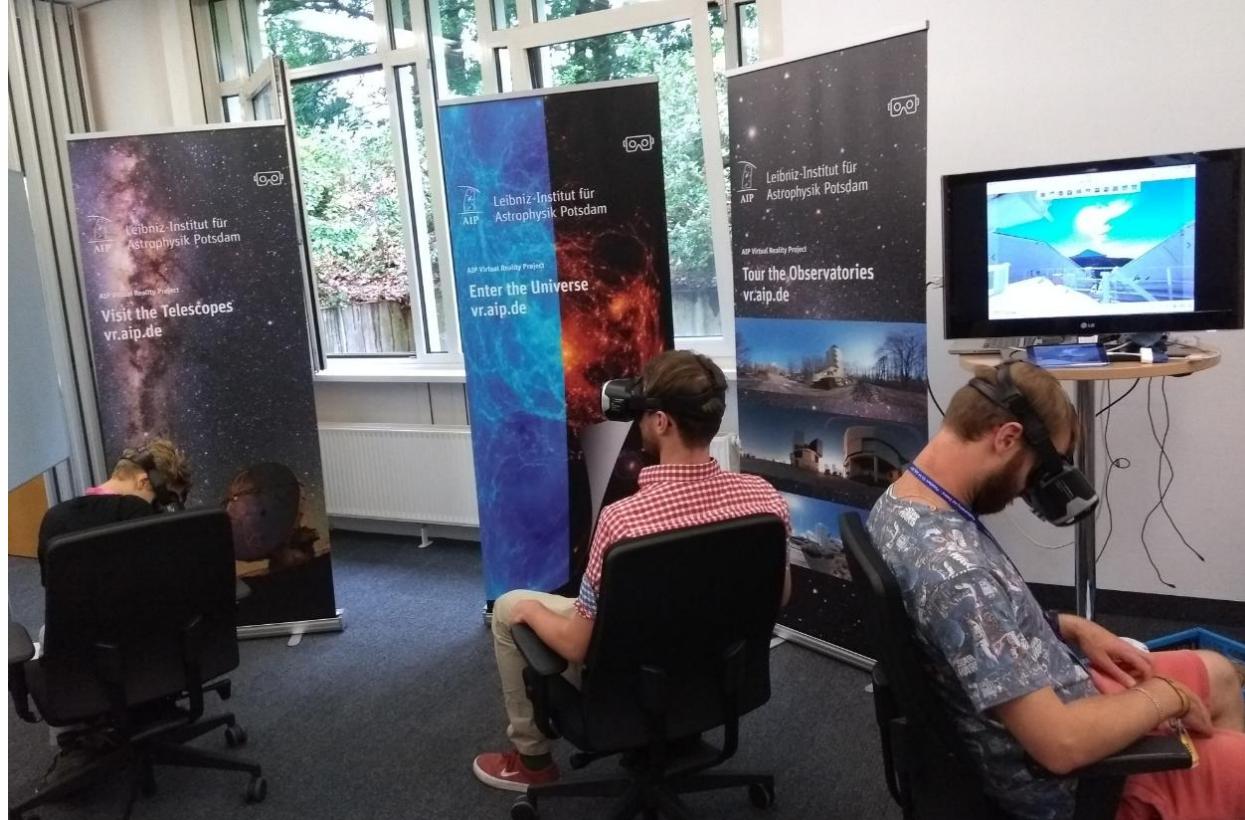


<https://vr.aip.de>



VR in conference IAUS 334, 2017

Cristina Chiappini



VR for parliament members





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But...

- Longer than 10 min VR is not human friendly
- Movies or scenes one should prepared carefully
 - Headache
 - vomiting alarm
 - Hygiene is important: direct face contact.



Conclusion

- Making nice visualizations is important
- Press releases
- Public outreach
- 3D is outdated, exists only in special cinemas
- VR is nice to have, but one should be careful with health and hygiene
- XR: Mixed Reality is the new tech to consider for bigger impacts

The VR/AR is dead, long live the XR

The initial version of WebVR was announced in 2016, with the aim of bringing VR content to the web.

then it is reworked to webXR with no limits on HW:

And since we don't want to be limited to just one facet of **VR** or **AR** (or anything in between) we use "X", not as part of an acronym but as an algebraic variable of sorts to indicate "Your Reality Here". We've also heard it called "Extended Reality" and "**Cross Reality**", which seem fine too, but really the X is whatever you want it to be!

<https://github.com/immersive-web/webxr/blob/master/explainer.md#what-is-webxr>



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THANK YOU