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Visual Exploration of Multifaceted Halo Data Sets

Introduction

- Halos in cosmological simulations often have many properties
- Exploration of halos in high dimensional data space is non-trivial
- We present a visualization framework that assists users to explore halos of interest

Task Characterization

- Visualize multi-faceted halo properties
- Facilitate exploration of halos of interest
- Enable easy query specification
- Support responsive and flexible interactions

System Design

PCP View

- Visualize multiple facets

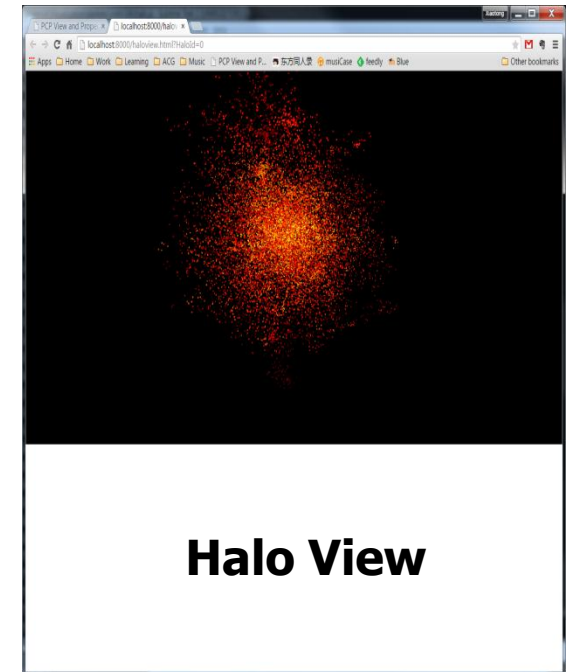
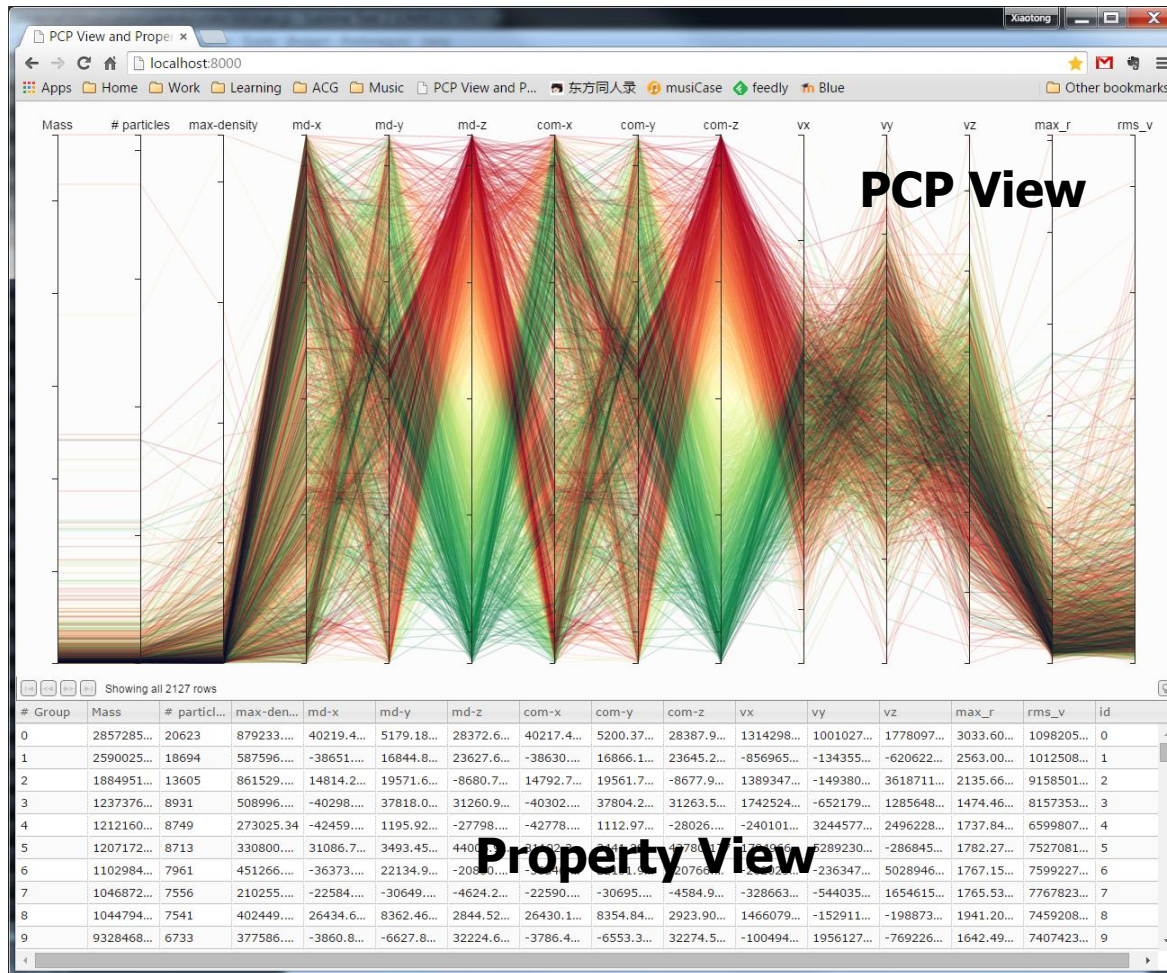
Property View

- Display specific values

Halo View

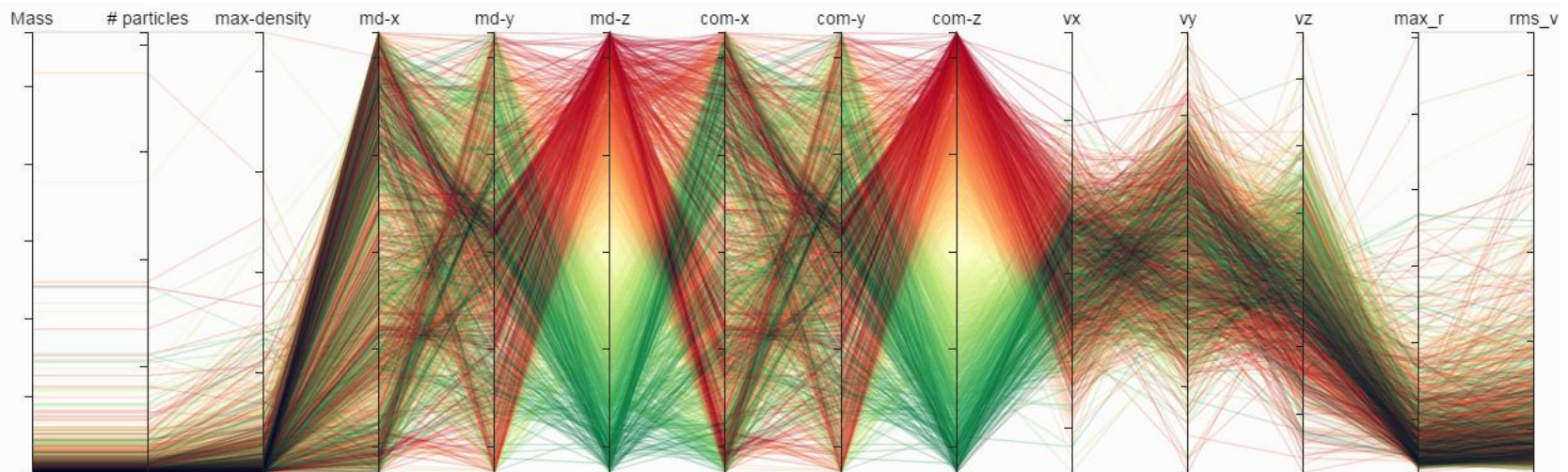
- Visualize particles of a halo

System Overview



PCP View

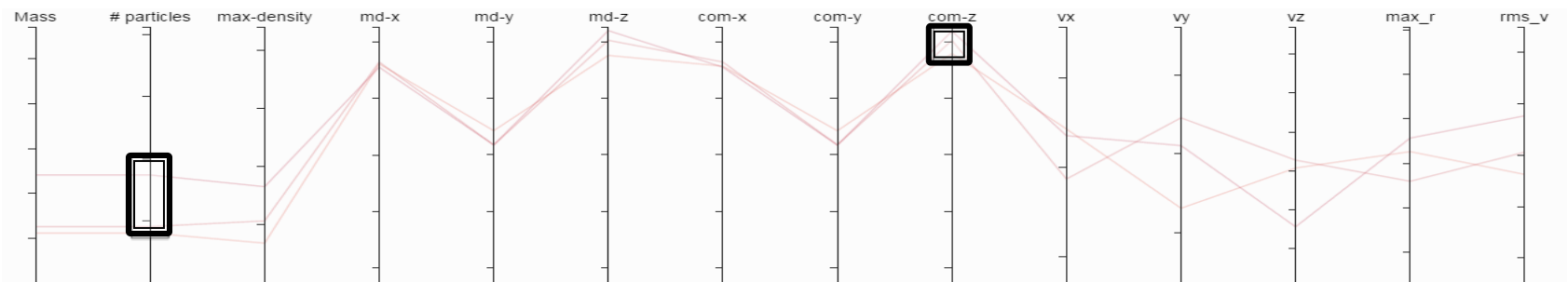
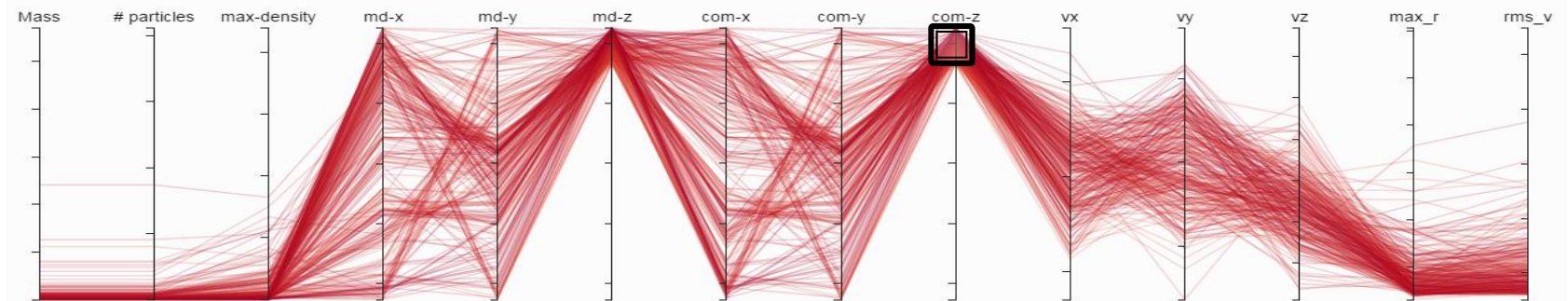
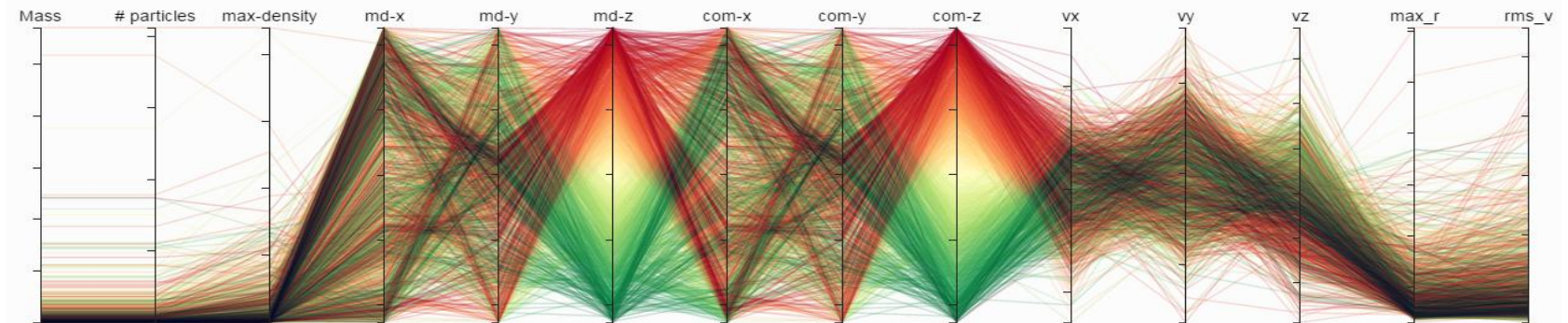
- Parallel Coordinates Plot
 - dimension axes: property facets
 - a halo in multiple-dimensional space as a polyline



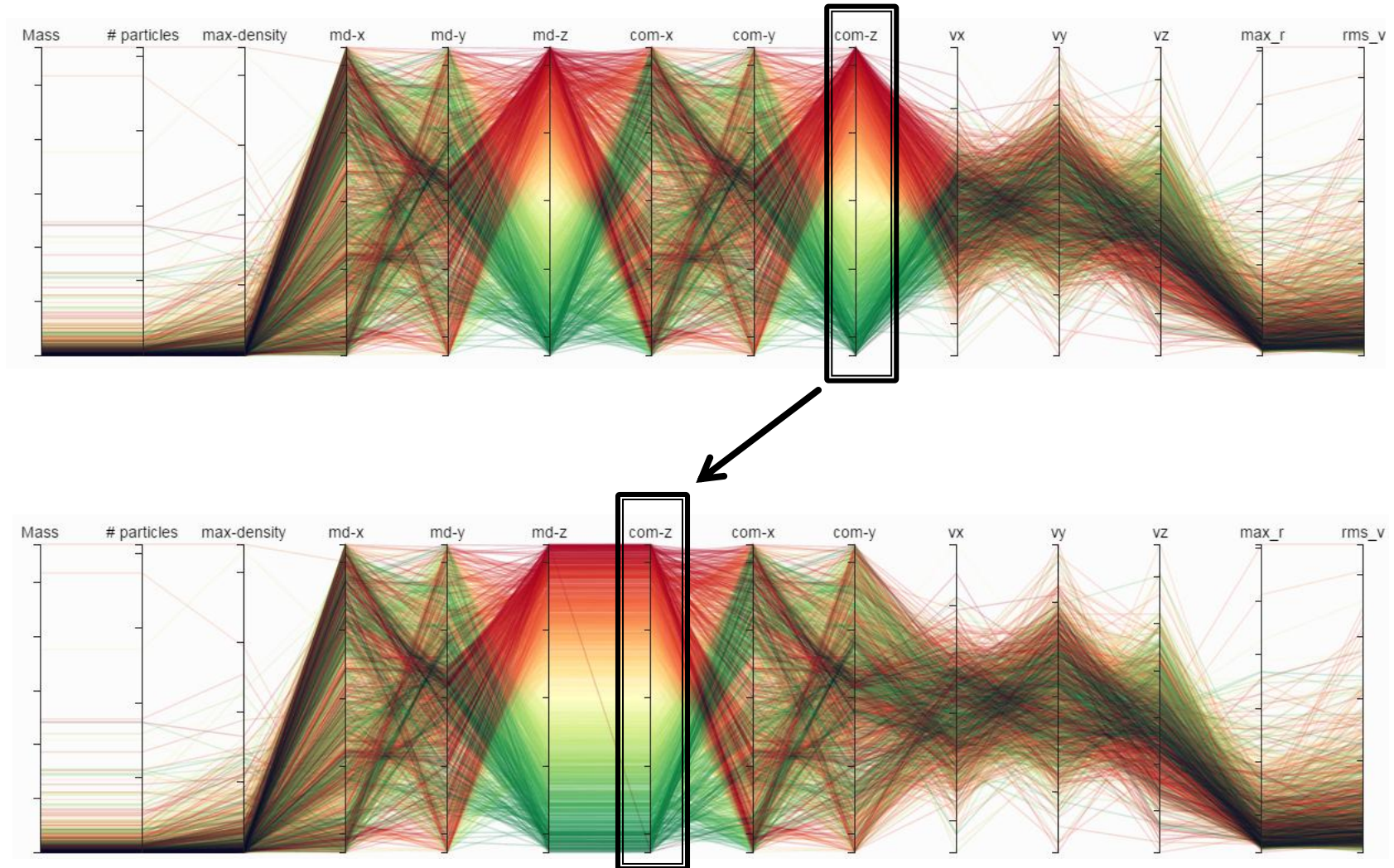
Interactions and Rendering

- Brushing and linking
- Axis reordering
- Progressive rendering

Brushing and Linking



Axis Reordering



Progressive Rendering

- Put all the polylines in a queue
- Render a subset of polylines per frame
- Build up the final image progressively

Property View

- Dynamic table
 - showing specific property values of halos
 - columns: properties
 - rows: halos

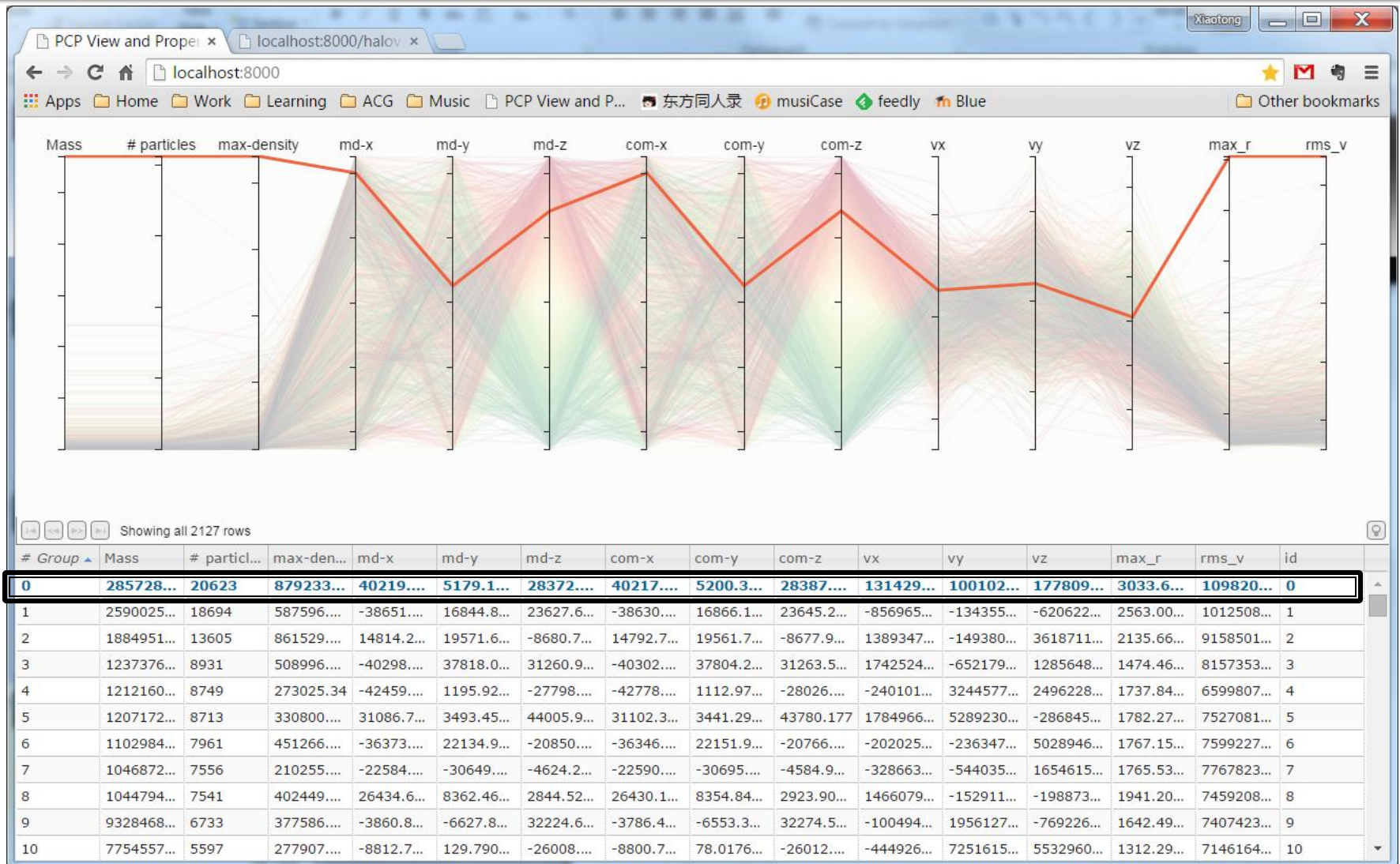
Showing all 2127 rows

# Group	Mass	# partic...	max-den...	md-x	md-y	md-z	com-x	com-y	com-z	vx	vy	vz	max_r	rms_v	id
0	2857285...	20623	879233....	40219.4...	5179.18...	28372.6...	40217.4...	5200.37...	28387.9...	1314298...	1001027...	1778097...	3033.60...	1098205...	0
1	2590025...	18694	587596....	-38651....	16844.8...	23627.6...	-38630....	16866.1...	23645.2...	-856965...	-134355...	-620622...	2563.00...	1012508...	1
2	1884951...	13605	861529....	14814.2...	19571.6...	-8680.7...	14792.7...	19561.7...	-8677.9...	1389347...	-149380...	3618711...	2135.66...	9158501...	2
3	1237376...	8931	508996....	-40298....	37818.0...	31260.9...	-40302....	37804.2...	31263.5...	1742524...	-652179...	1285648...	1474.46...	8157353...	3
4	1212160...	8749	273025.34	-42459....	1195.92...	-27798....	-42778....	1112.97...	-28026....	-240101...	3244577...	2496228...	1737.84...	6599807...	4
5	1207172...	8713	330800....	31086.7...	3493.45...	44005.9...	31102.3...	3441.29...	43780.177	1784966...	5289230...	-286845...	1782.27...	7527081...	5
6	1102984...	7961	451266....	-36373....	22134.9...	-20850....	-36346....	22151.9...	-20766....	-202025...	-236347...	5028946...	1767.15...	7599227...	6
7	1046872...	7556	210255....	-22584....	-30649....	-4624.2...	-22590....	-30695....	-4584.9...	-328663...	-544035...	1654615...	1765.53...	7767823...	7
8	1044794...	7541	402449....	26434.6...	8362.46...	2844.52...	26430.1...	8354.84...	2923.90...	1466079...	-152911...	-198873...	1941.20...	7459208...	8
9	9328468...	6733	377586....	-3860.8...	-6627.8...	32224.6...	-3786.4...	-6553.3...	32274.5...	-100494...	1956127...	-769226...	1642.49...	7407423...	9
10	7754557...	5597	277907....	-8812.7...	129.790...	-26008....	-8800.7...	78.0176...	-26012....	-444926...	7251615...	5532960...	1312.29...	7146164...	10

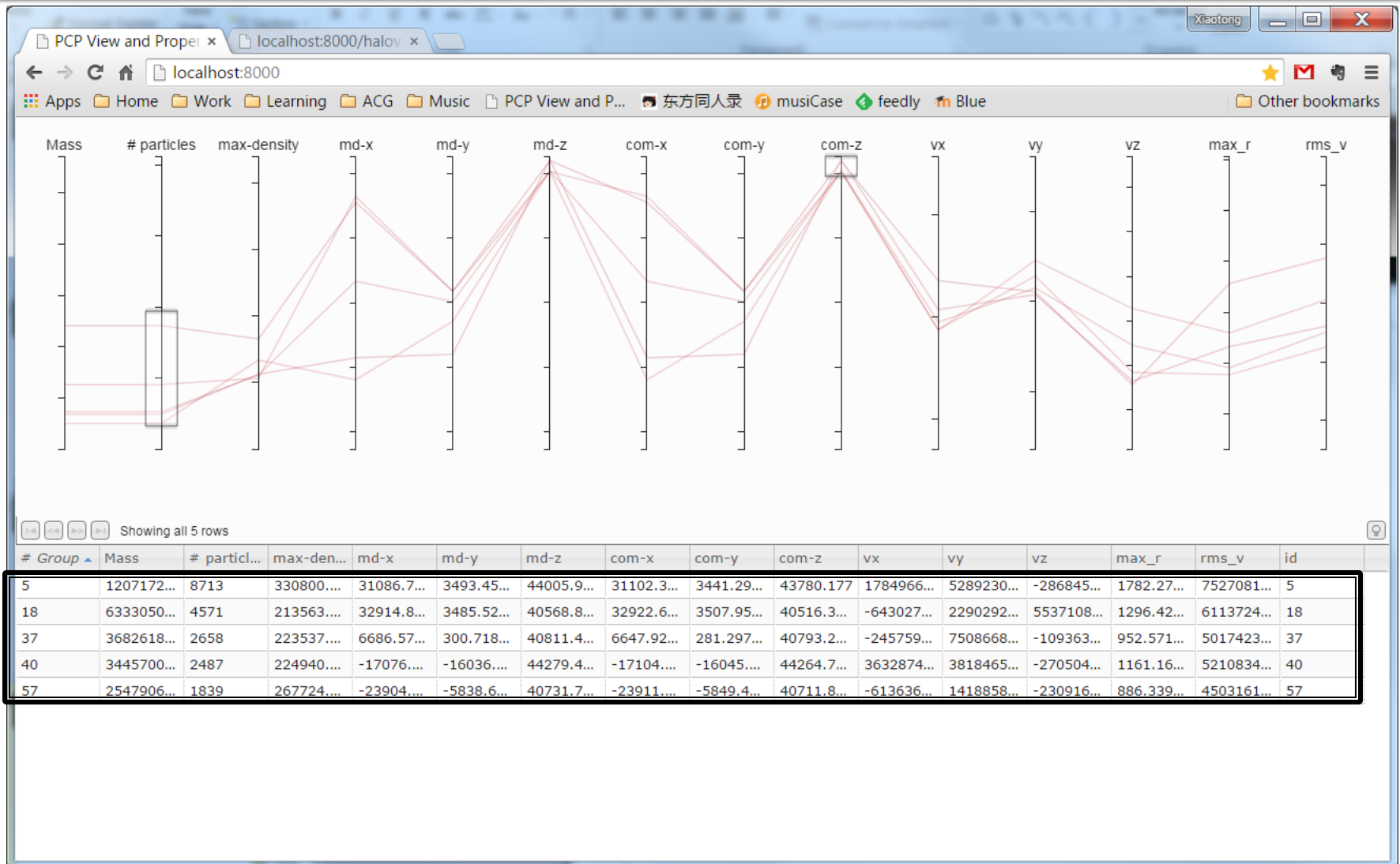
Dynamic Table

- Dimension-oriented sorting
- Linking with the PCP view
 - Highlight a specific halo in the PCP view
 - Zoom into a subset of halos for exploration
- Linking with the Halo view

Highlighting a Specific Halo

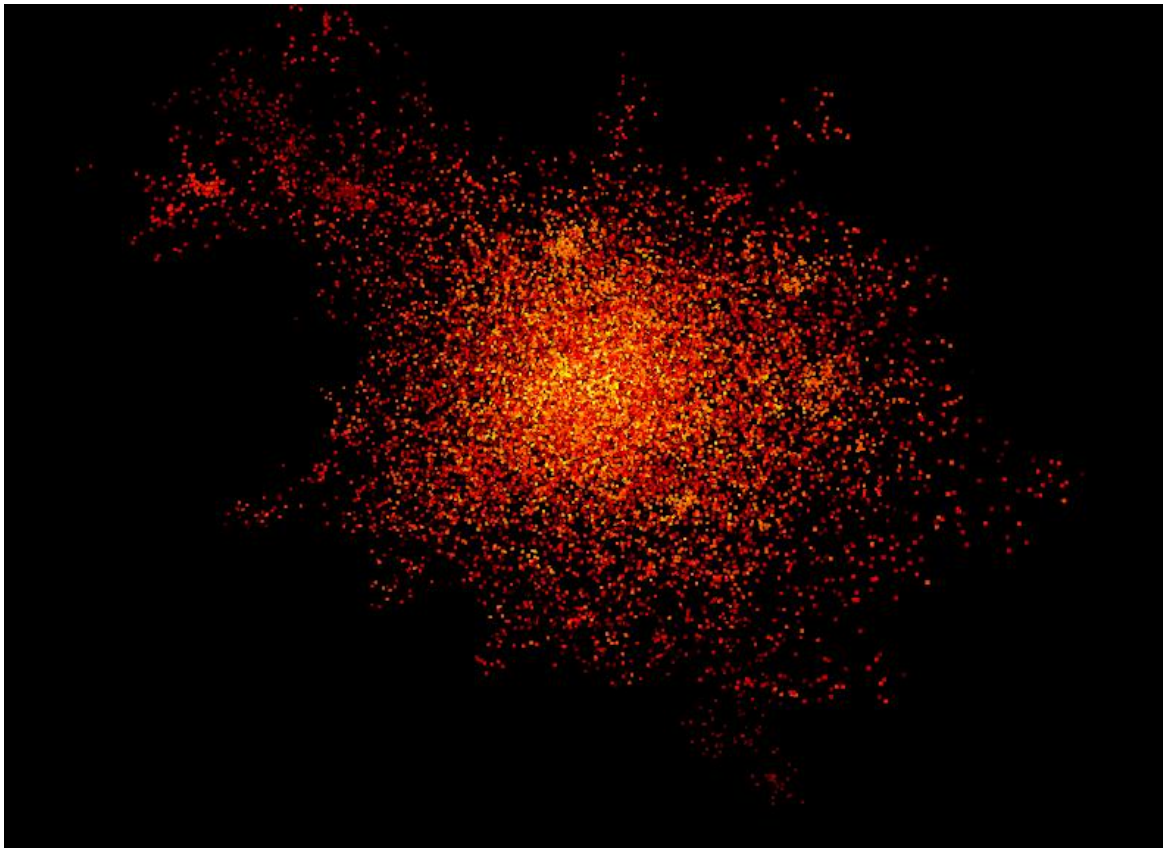


Subset Exploration



Halo View

- Particle rendering of the selected halo



Visual Encodings

Live Demo

Results and Discussion

- Most halos have relatively few particles
- The mass of a halo is positively correlated to the number of particles
- The maximum density particle more or less represents the center of mass for the halo

Implementation

- **Yt.py** is used to read and process the raw particle data in SDF format
- **D3.js** is used to create the interactive PCP view and the Property view
- **WebGL** is used to render the particles in the halo view

Future Work

- To provide more interactions such as zooming and panning in the Halo view
- To further compare the particles that compose different halos
- To combine with other groups for VIS'15 contest submission

Question?