2018年1.0版本开始使用Julia

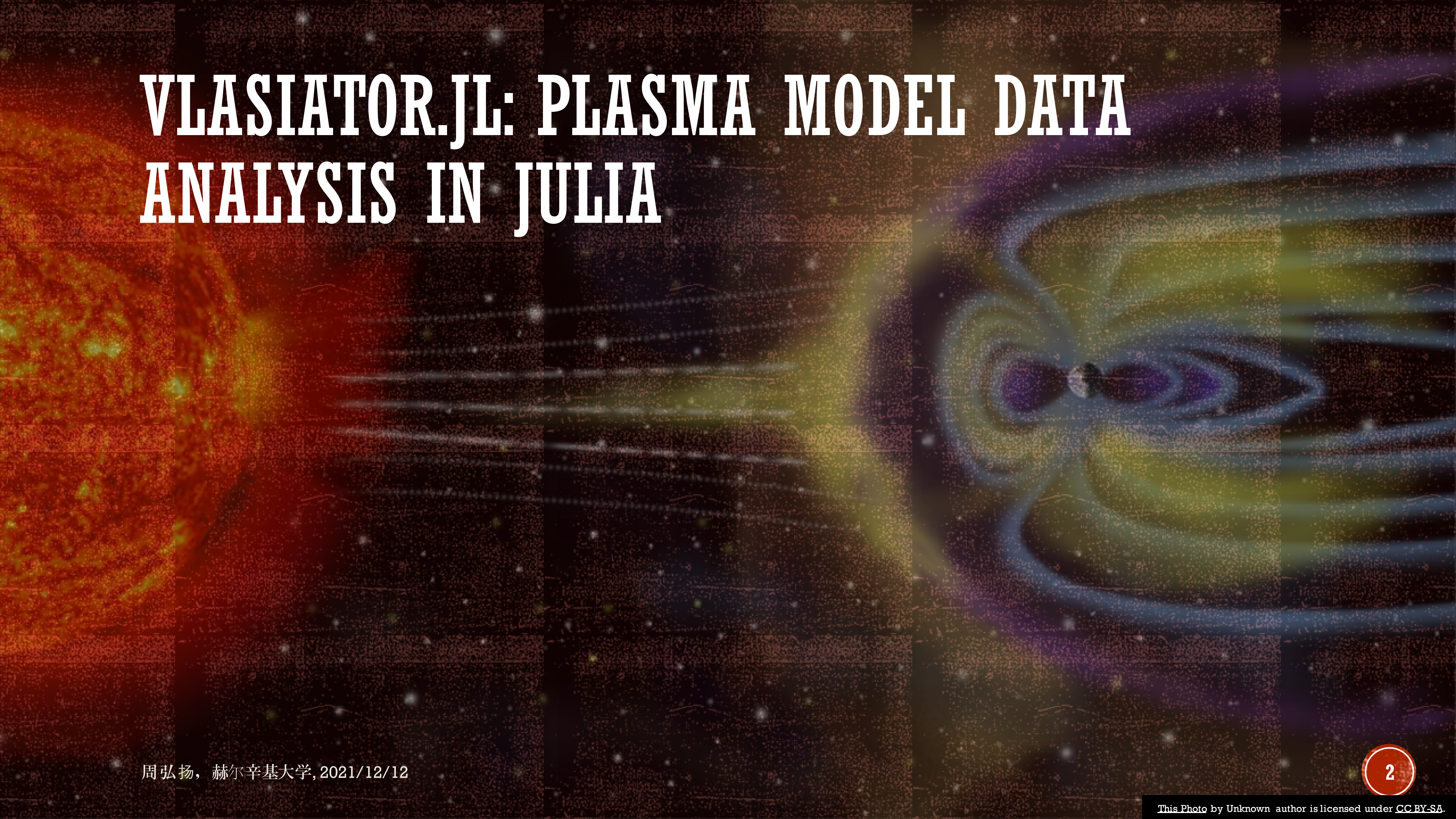
博士后任职于芬兰赫尔辛基大学物理系，从事行星磁场相关研究

GitHub: henry2004y

- 微分方程数值解
- 数据分析与图像绘制
- 通用编程小项目实践

周弘扬，赫尔辛基大学, 2021/12/12

VLASIATOR.JL: PLASMA MODEL DATA ANALYSIS IN JULIA



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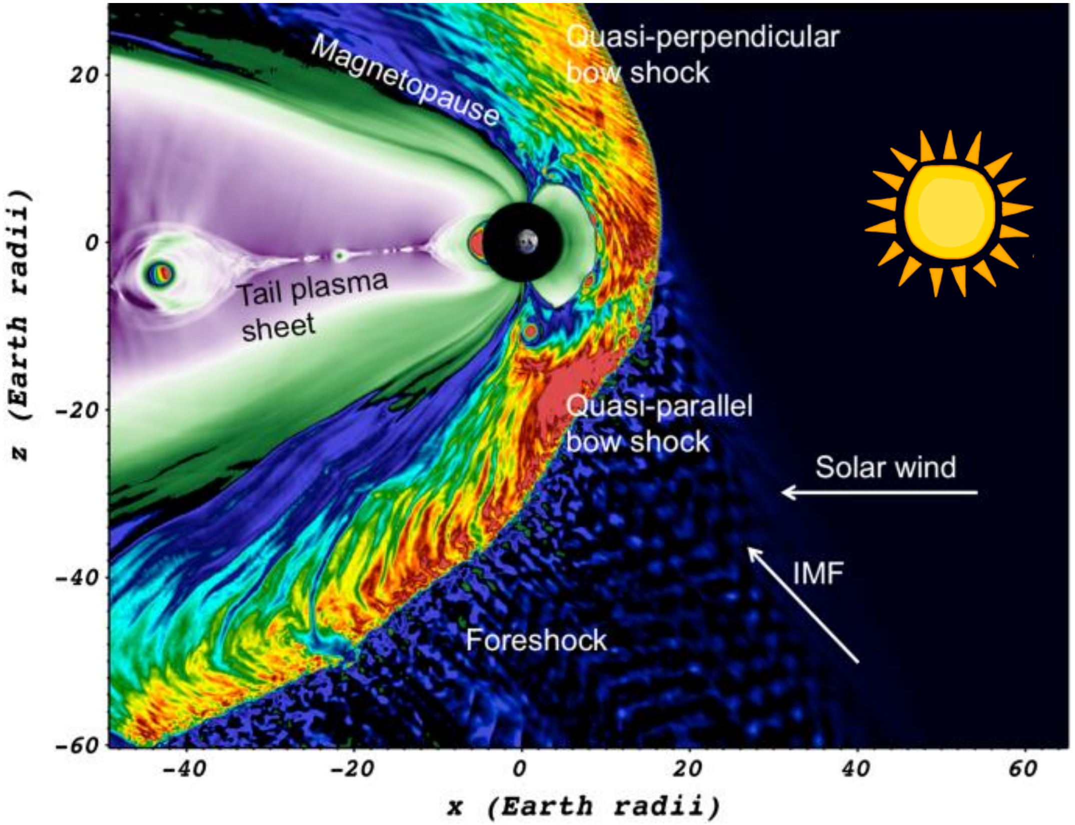
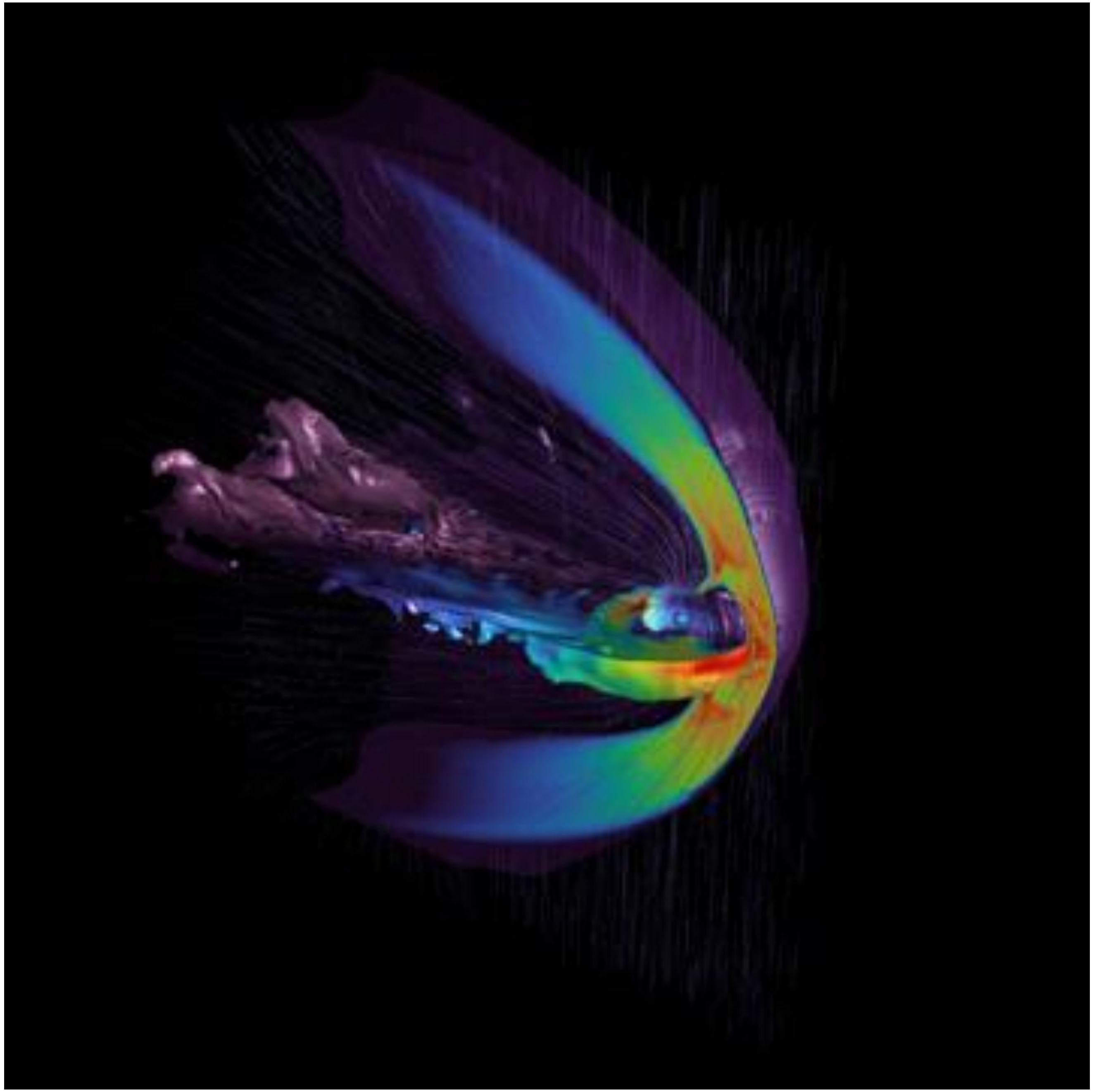
WHAT IS VLASIATOR?

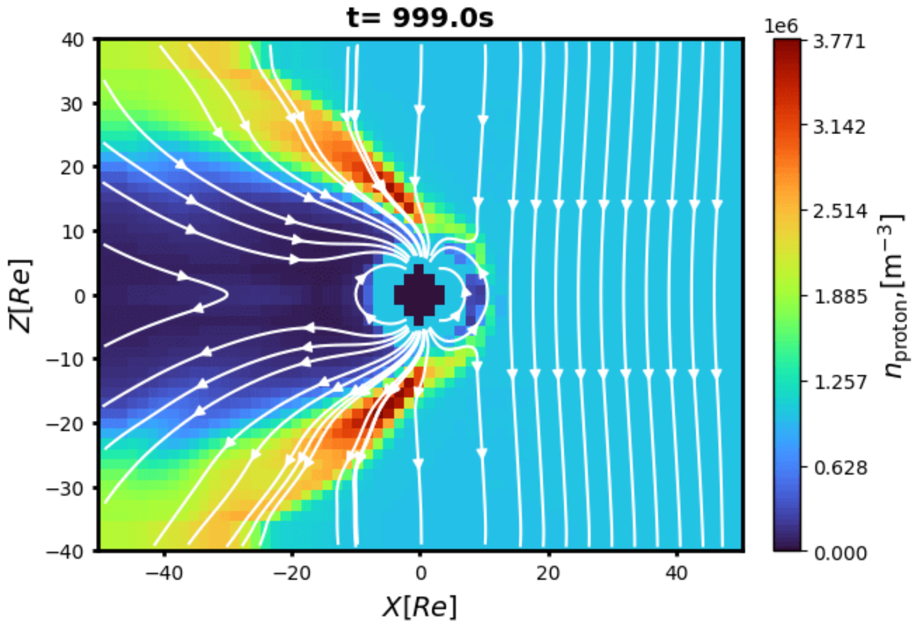


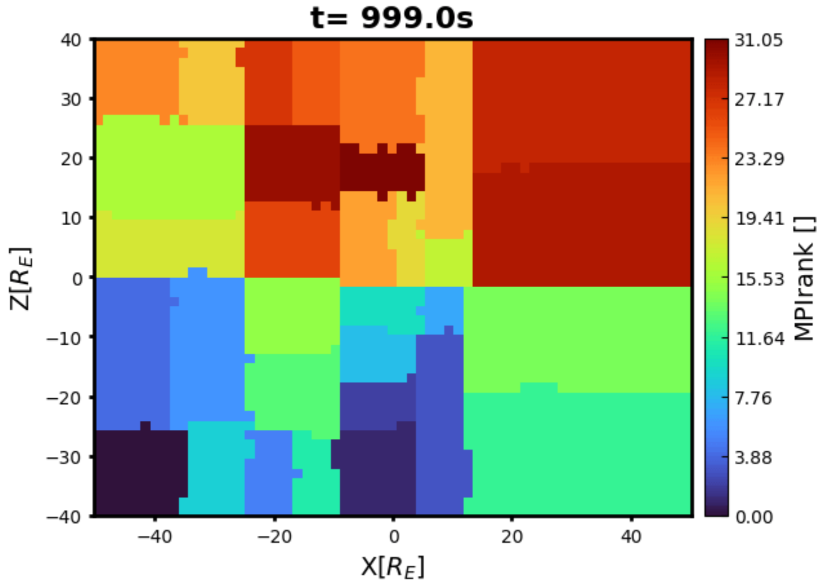
- Space weather
- Near-Earth Space Modelling
- Plasma
  - Ionized gas
  - Particle + Fluid
  - Phase space description
- 6-dimension PDE solver



WHAT PROGRAMMING TOOLS ARE WE USING?

- Core program in C++11
  - MPI + OpenMP
- Analysis toolbox in Python
  - numpy
  - matplotlib
- C reader plugin for VisIt
- **Vlasiator.jl**

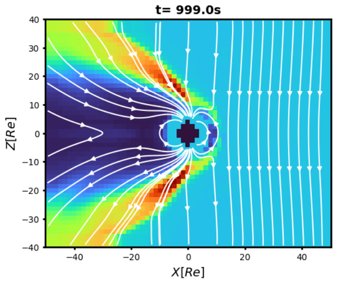


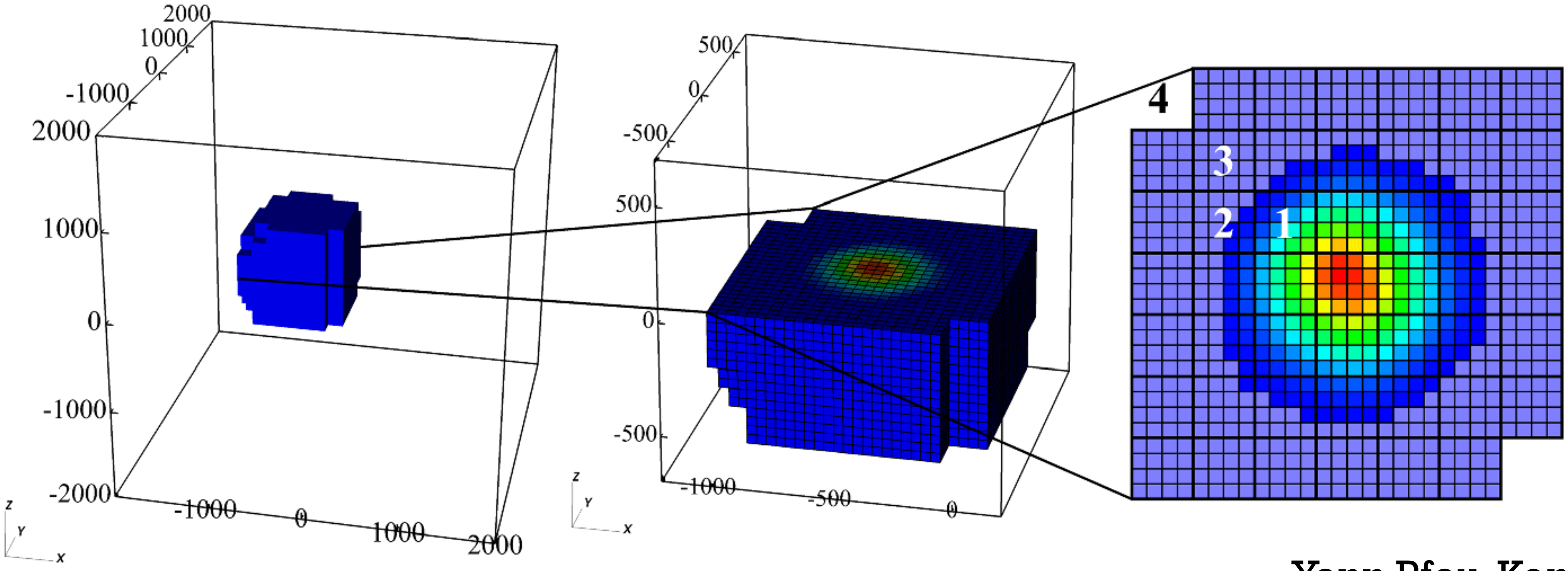


Random ordering

WHAT IS VLASIATOR.JL?

- Data reader
- Post-processing
- File format converter
- Visualization





Yann Pfau-Kempf, 2016

WHAT IS VLASIATOR.JL?

Large memory usage

- Data reader
- Post-processing
- File format converter
- Visualization

TECHNIQUES

- XML parser
- Memory mapped I/O
- Plotting recipes
- Adaptive Mesh Refinement (AMR)
- Function barrier
- Index search

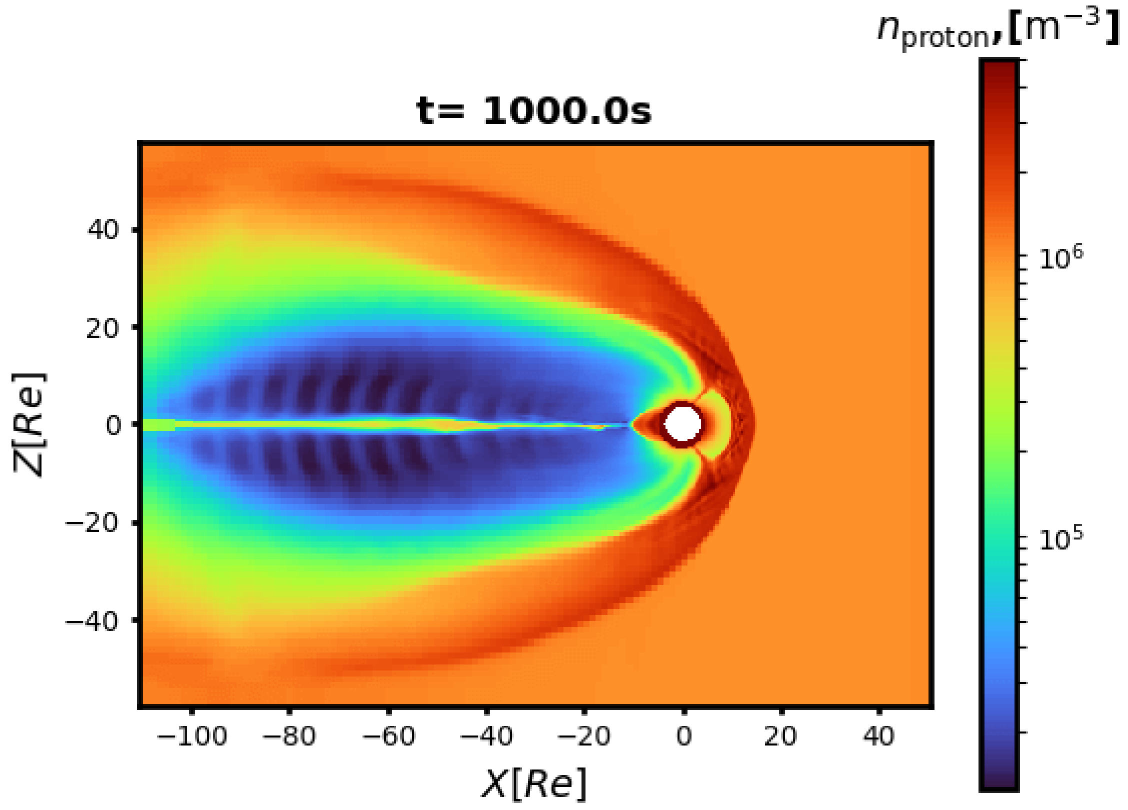
TECHNIQUES: XML PARSER

- Customized XML data format
- Current usable libs all depend on libxml2 (C library)
  - EzXML.jl
  - LightXML.jl
- EzXML.jl is chosen
  - Slower to load
  - Consumes less memory in runtime
  - Presumably safer in avoiding memory leaks

TECHNIQUES: MMAP & STREAM

- Stream
  - Faster for random access
  - Robust and portable
- Memory mapped I/O (mmap in stdlib)
  - Useful when data are larger than RAM
  - Faster for large chunks of data
  - ❑Must be aligned with page size
    - ❑Map as Vector{UInt8}
    - ❑reinterpret
  - ❑Significantly slower in some operations
    - ❑e.g. findall
- Mixture of both in the reader

TECHNIQUES: PLOTTING RECIPES



- PyPlot (Matplotlib)
  - Most complete support
  - Production ready
  - Dependency on Python
- Plots
  - Nice user recipe design
  - Huge mess in backend supports
  - Terrible documentation
- Makie
  - Extremely slow first-time-to-plot
  - Much better in recent versions
  - Remarkable 3D and interactive widgets

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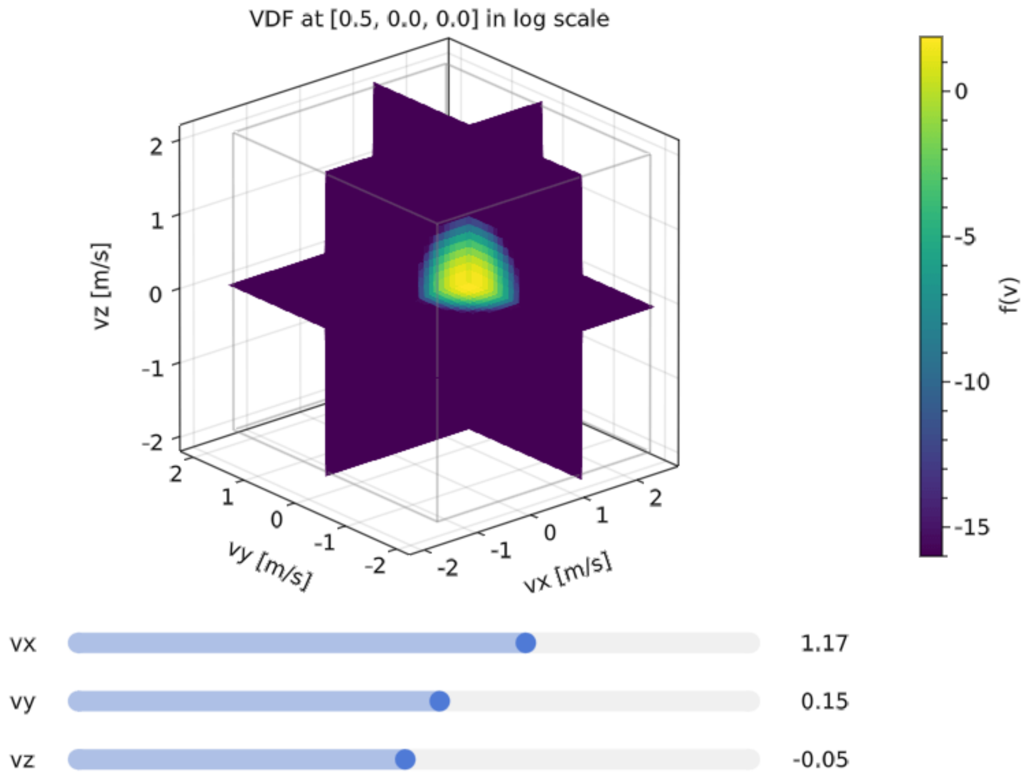

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FUTURE ROADMAP

- Embedded multithreading?
  - Learning from CSV.jl?
- Frontend GUI app?
  - Until Julia 2.0?
- More than just a data processor
  - Porting C++ codes to Julia
  - Native PDE solver in Julia

REFERENCES

- Vlasiator.jl Documentation