



# ¡Como la Comunidad de Astronomía se está Beneficiando de las TIC!

Liliana Hernández-Cervantes (IA, UNAM)

Alfredo J. Santillán (DGTIC, UNAM)

¡La vida es dura!



← La Villa  
→ Patio Gavilán  
← Vacation Club  
← La Pergola  
← Al fresco Trattoria

ALFAGUARA

# Elena Poniatowska

## La piel del cielo

Premio  
ALFAGUARA  
de novela  
2001

Seix Barral *LOS TRES MUNDOS* *Biografía*

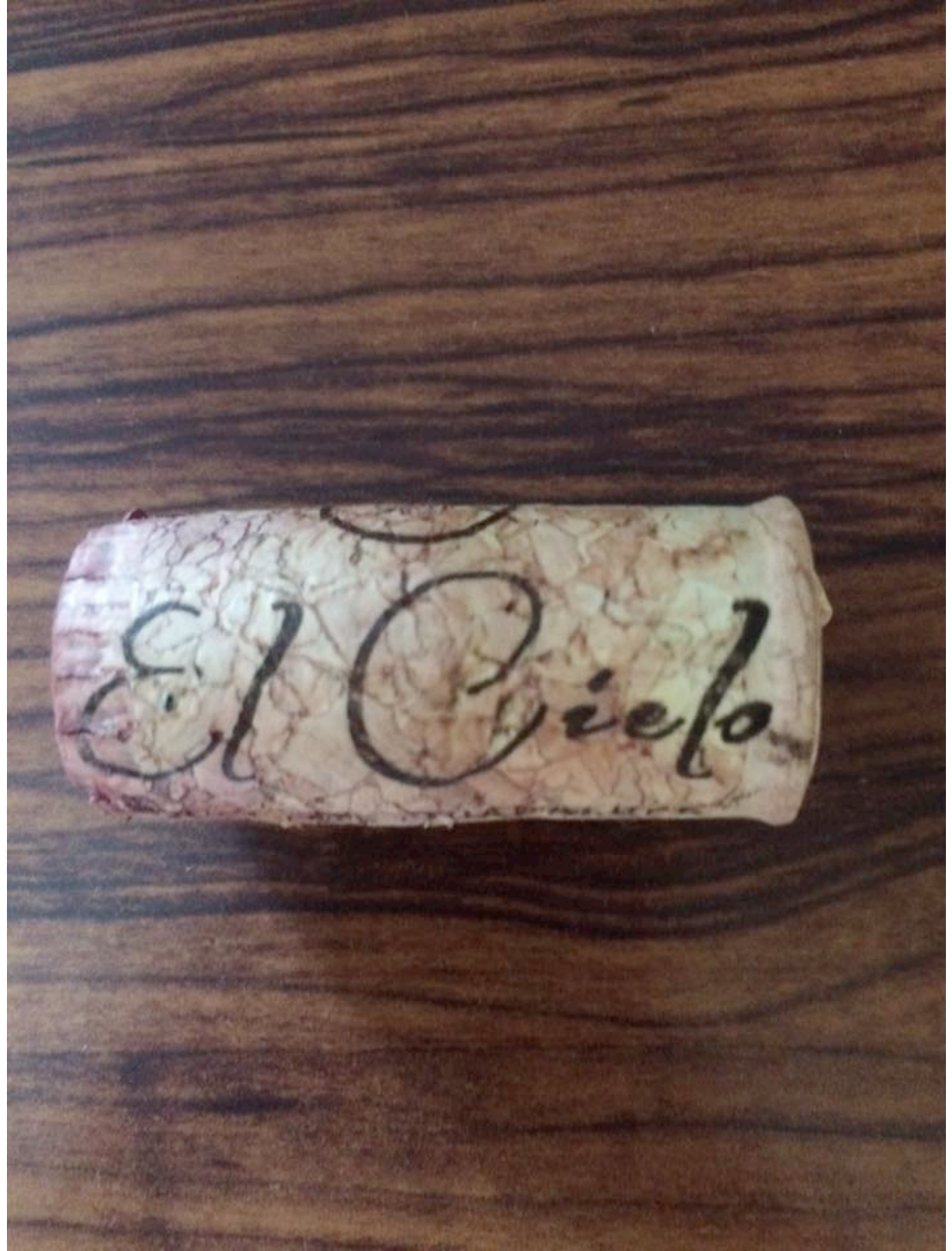


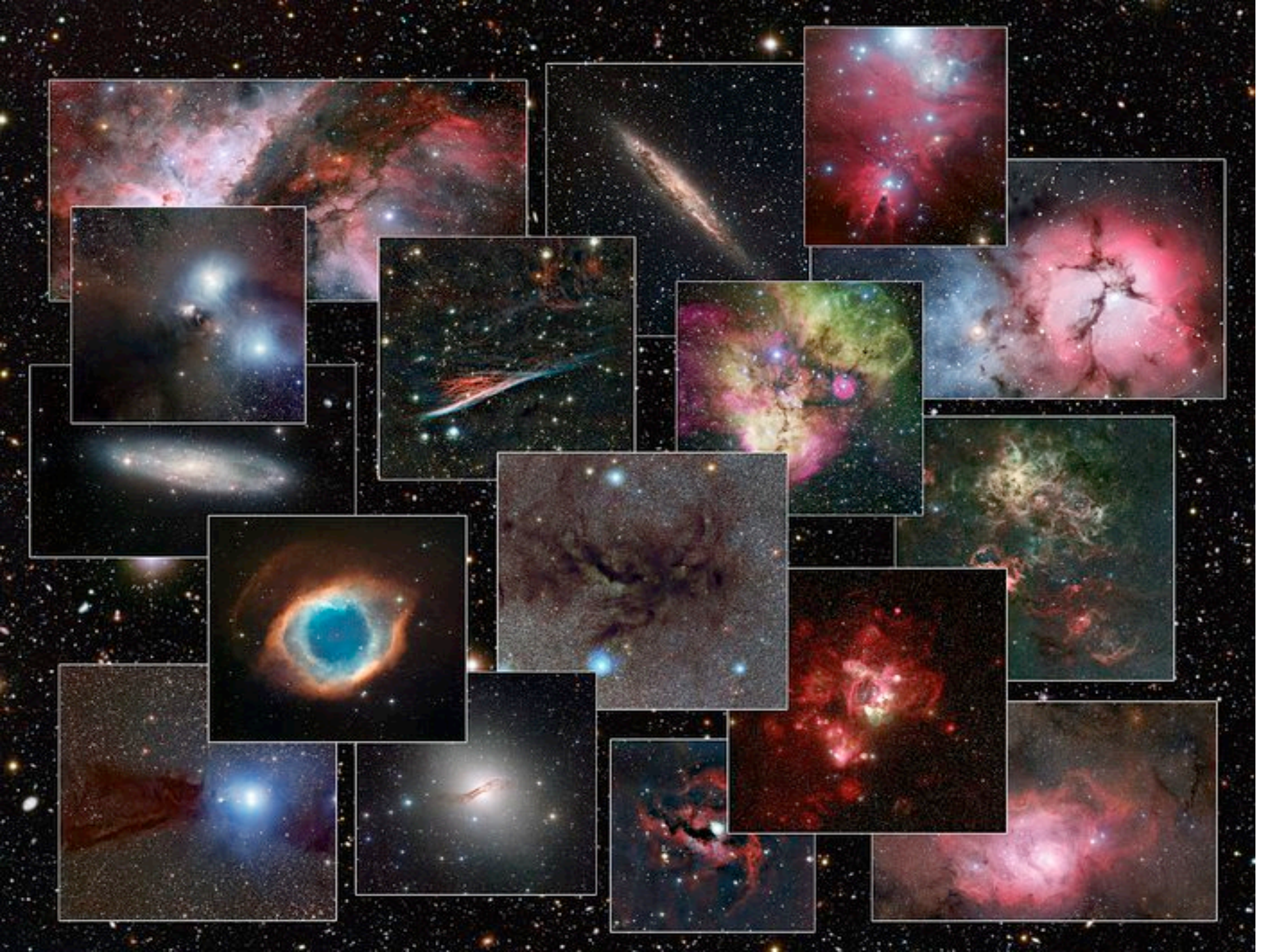
# Elena Poniatowska

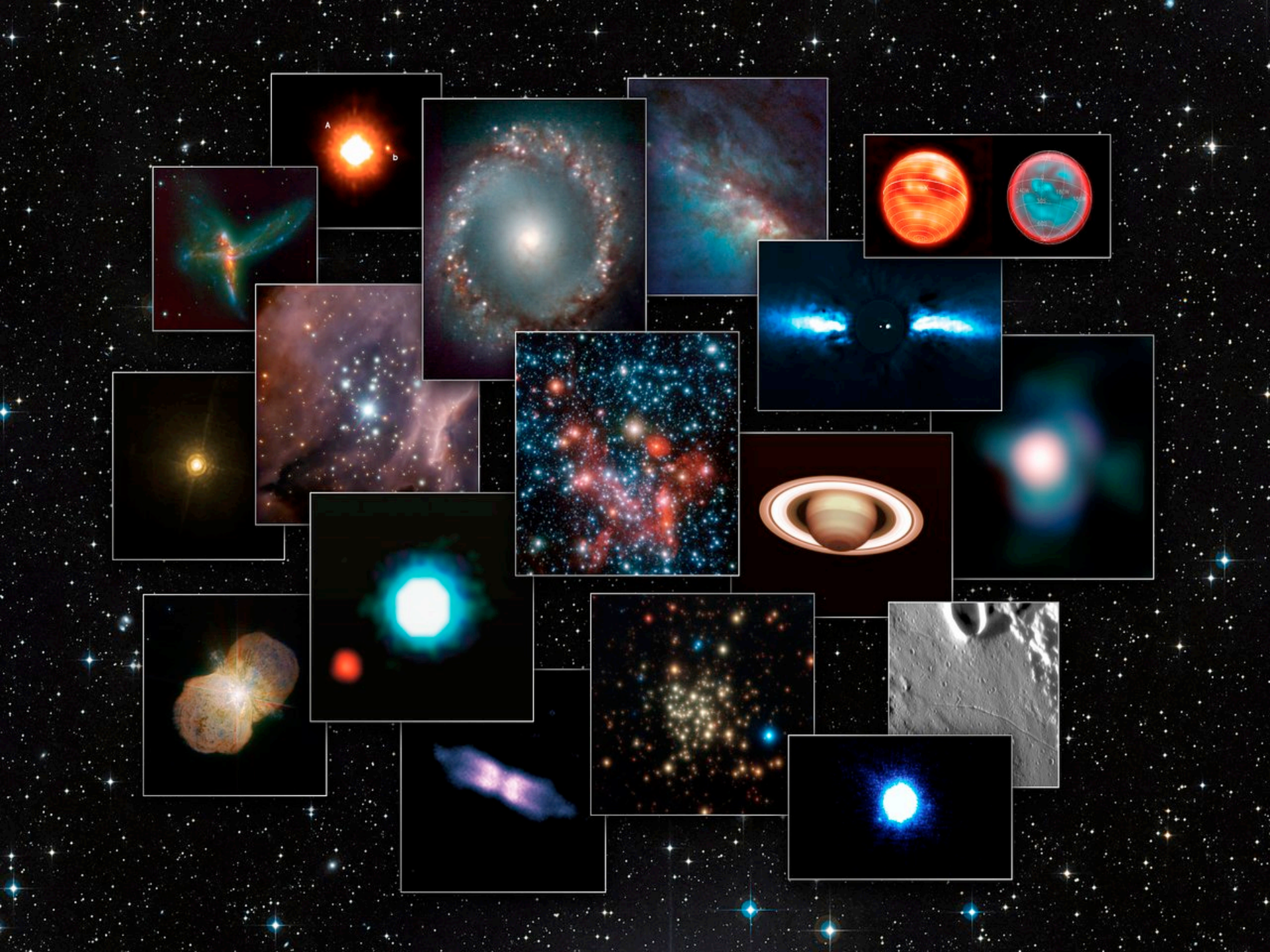
## El universo o nada

Biografía del estrellero Guillermo Haro





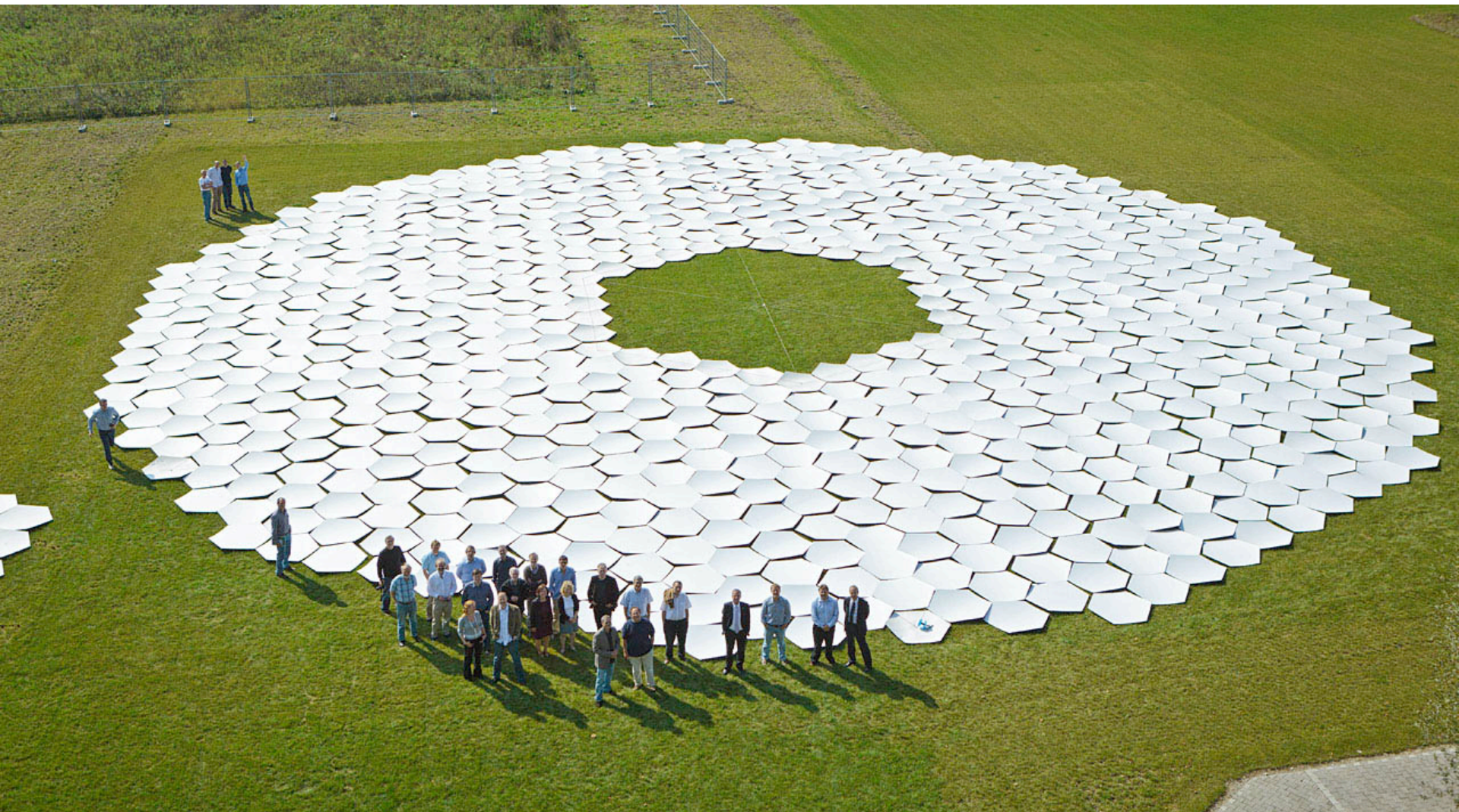




# E-ELT 42m



# E-ELT 42m





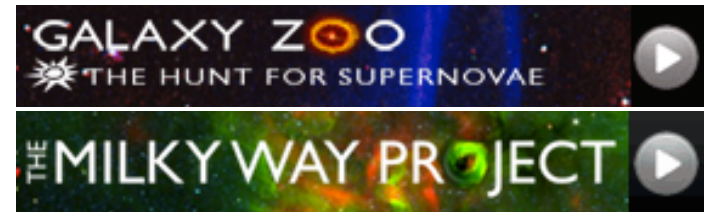


# Sunway TaihuLight



10,649,600 Cores

# TIC



# Google™ Maps

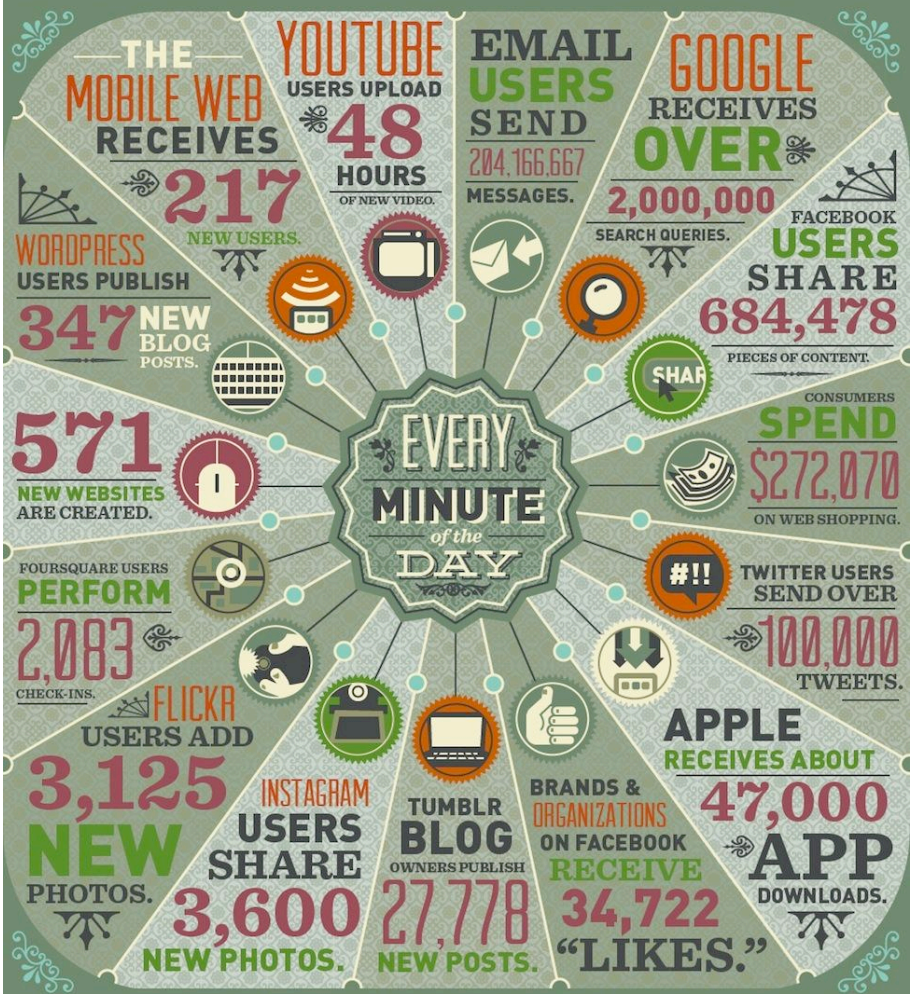




# DATA NEVER SLEEPS

How Much Data Is Generated Every Minute?

Big data is not just some abstract concept used to inspire and mystify the IT crowd; it is the result of an avalanche of digital activity pulsating through cables and airwaves across the world. This data is being created every minute of the day through the most innocuous of online activity that many of us barely even notice. But with every website browsed, status shared, or photo uploaded, we leave digital trails that continually grow the hulking mass of big data. Below, we explore how much data is generated in one minute on the internet.



### WITH NO SIGNS OF SLOWING, THE DATA KEEPS GROWING

These are just some of the more common ways that Internet users add to the big data pool. In truth, depending on the niche of business you're in, there are virtually countless other sources of relevant data to pay attention to. Consider the following:

The global Internet population grew 6.59 percent from 2010 to 2011 and now represents

## 2.1 BILLION PEOPLE.

These users are real, and they are out there leaving data trails everywhere they go. The team at Domo can help you make sense of this seemingly insurmountable heap of data, with solutions that help executives and managers bring all of their critical information together in one intuitive interface, and then use that insight to transform the way they run their business. To learn more, visit [www.domo.com](http://www.domo.com).

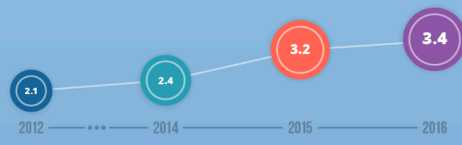
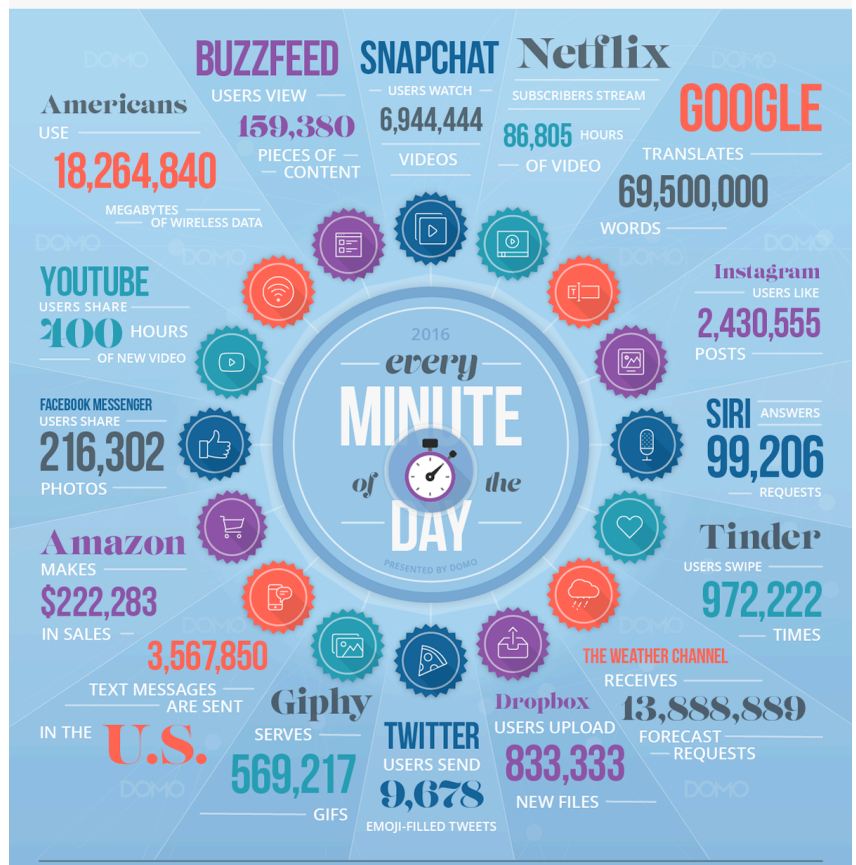


SOURCES: [HTTP://NEWS.INVESTORS.COM](http://NEWS.INVESTORS.COM), [ROYAL.PINEDOM.COM](http://ROYAL.PINEDOM.COM), [BLOG.GROVO.COM](http://BLOG.GROVO.COM), [BLOG.HUBSPOT.COM](http://BLOG.HUBSPOT.COM), [SIMPLYZESTY.COM](http://SIMPLYZESTY.COM), [PCWORLD.COM](http://PCWORLD.COM), [BIZTECHMAGAZINE.COM](http://BIZTECHMAGAZINE.COM), [DIGBY.COM](http://DIGBY.COM)



# DATA NEVER SLEEPS 4.0

How much data is generated every minute? In the fourth annual edition of Data Never Sleeps, newcomers like Giphy and Facebook Messenger illustrate the rise of our multimedia messaging obsession, while veterans like Youtube and Snapchat highlight our insatiable appetite for video. Just how many GIFs, videos, and emoji-filled Tweets flood the internet every minute? See for yourself below.



GLOBAL INTERNET POPULATION GROWTH 2012-2016 (IN BILLIONS)

Data has become the new enterprise currency. The ability to collect, analyze, and leverage it effectively will distinguish the best from the rest. Domo helps you stay ahead by bringing your data and people together in the cloud, where everyone in your organization can easily access the information they need to make faster, better-informed decisions and optimize business performance.

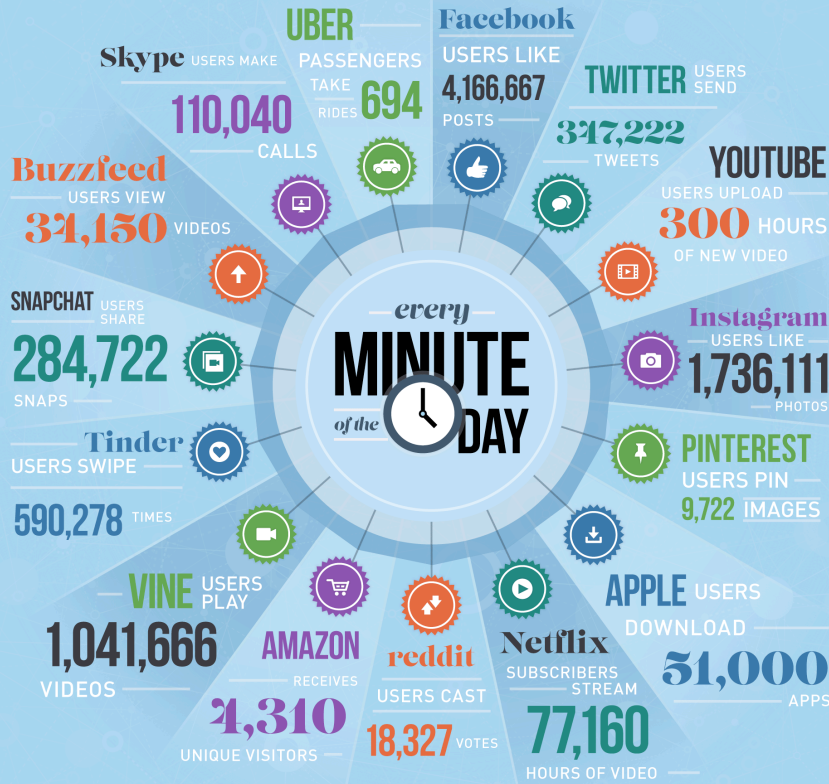
Learn more at [www.domo.com](http://www.domo.com)



SOURCES: SNAPCHAT, NETFLIX, GOOGLE, INSTAGRAM, TINDER, THE WEATHER COMPANY, DROPBOX, GITHUB, GIPHY, YOUTUBE, BUZZFEED, AMAZON, CTA, MARY MEEKER'S 2016 INTERNET TRENDS REPORT, USA TODAY, GLOBAL WEB INDEX.

How much data is generated every minute?

Data is being created all the time without us even noticing it. Much of what we do every day now happens in the digital realm, leaving an ever-increasing digital trail that can be measured and analyzed. Just how much data do our tweets, likes and photo uploads really generate? For the third time, Domo has the answer—and the numbers are staggering.



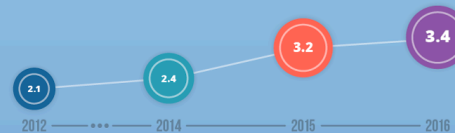
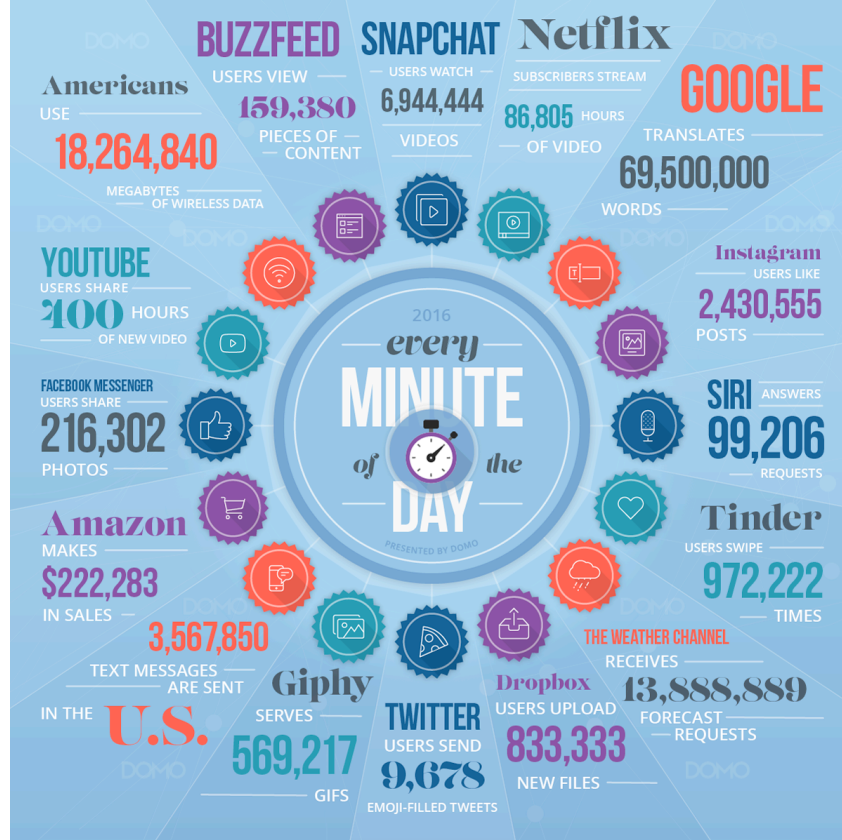
THE GLOBAL INTERNET POPULATION GREW 18.5% FROM 2013-2015 AND NOW REPRESENTS **3.2 BILLION PEOPLE.**

With each click, share and like, the world's data pool is expanding faster than we can comprehend. Businesses today are paying attention to scores of data sources to make crucial decisions about the future. The team at Domo can help your business make sense of this endless stream of data by providing executives with all their critical information in one intuitive platform. Domo delivers the insights you need to transform the way you run your business. [Learn more at www.domo.com.](http://www.domo.com)



SOURCES: FACEBOOK, TWITTER, YOUTUBE, INSTAGRAM, PINTEREST, APPLE, NETLIX, REDDIT, AMAZON, TINDER, BUZZFEED, STATISTA, INTERNET LIVE STATS, STATISTICBRAIN.COM

How much data is generated every minute? In the fourth annual edition of Data Never Sleeps, newcomers like Giphy and Facebook Messenger illustrate the rise of our multimedia messaging obsession, while veterans like Youtube and Snapchat highlight our insatiable appetite for video. Just how many GIFs, videos, and emoji-filled Tweets flood the Internet every minute? See for yourself below.



GLOBAL INTERNET POPULATION GROWTH 2012-2016 (IN BILLIONS)

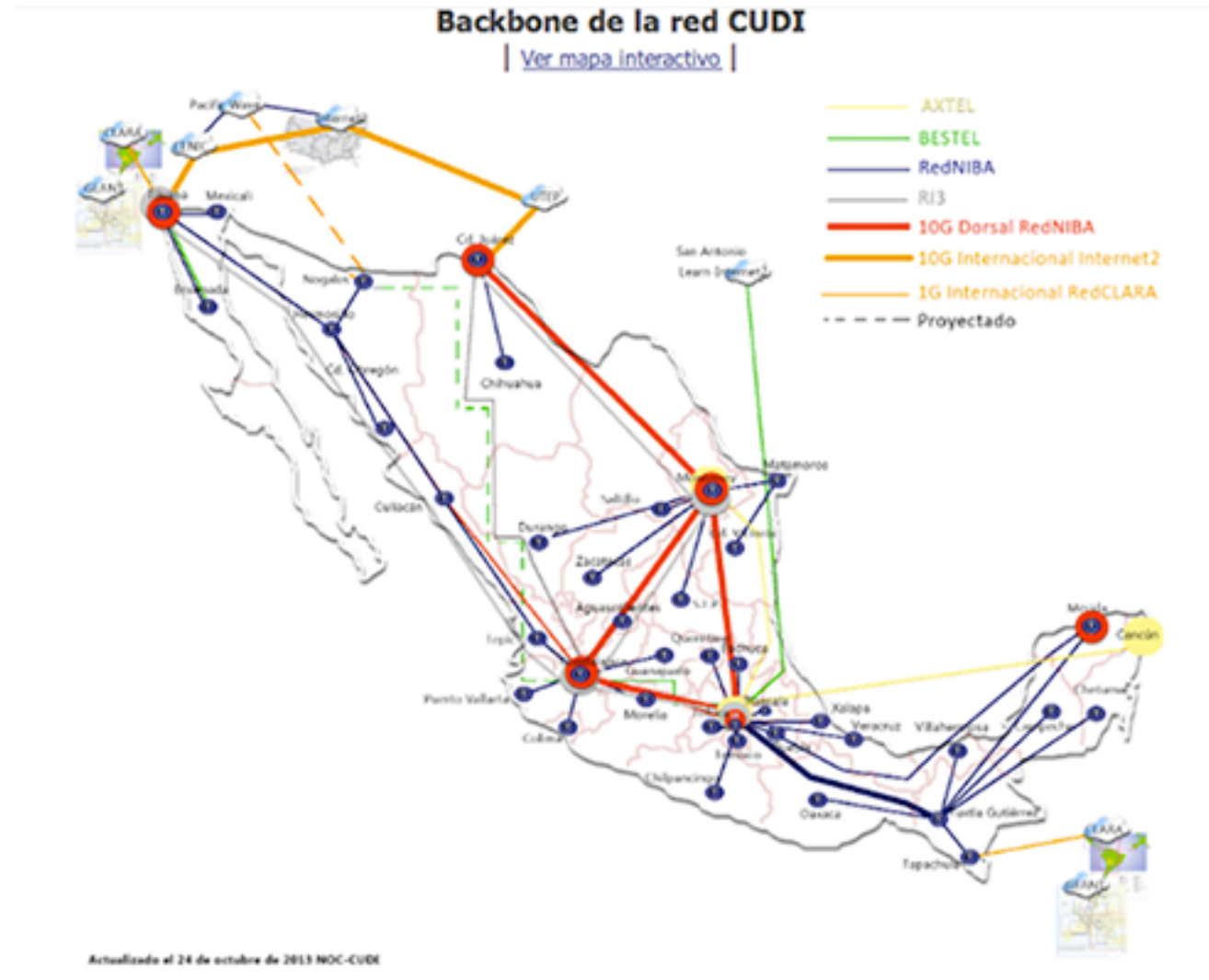
Data has become the new enterprise currency. The ability to collect, analyze, and leverage it effectively will distinguish the best from the rest. Domo helps you stay ahead by bringing your data and people together in the cloud, where everyone in your organization can easily access the information they need to make faster, better-informed decisions and optimize business performance.

[Learn more at www.domo.com](http://www.domo.com)



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# Dorsal de la Red CUDI





**¡Dispositivos móviles!**

**¡Lotería Cósmica!**



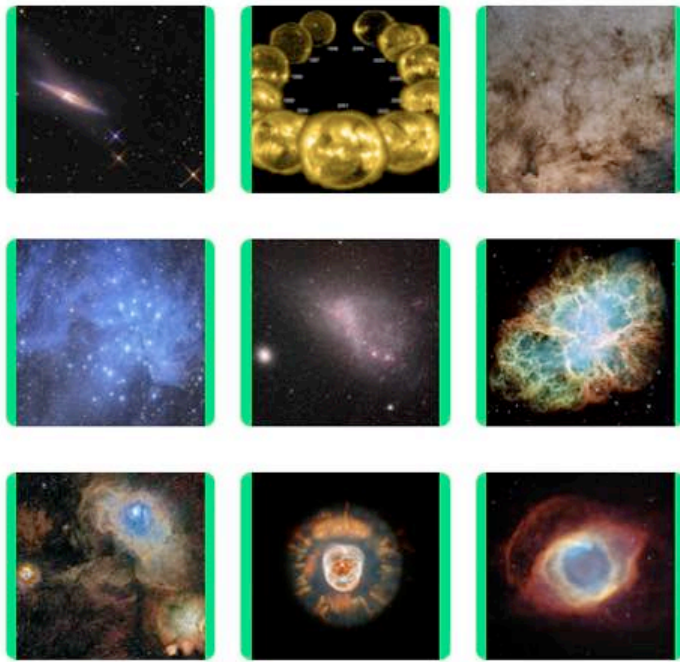
# Lotería Cósmica

2008  
Presencial

2010  
CUDI

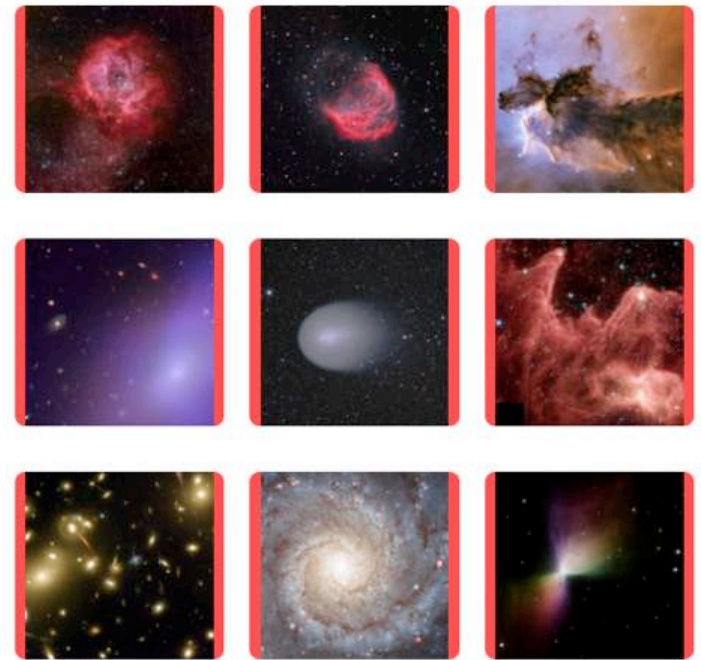
2017  
Dis.Mov.

# Lotería Cósmica



Galaxia Espiral  
¡M74!

Inicio



Cúmulo de Galaxias  
¡Abel 2218!

Inicio



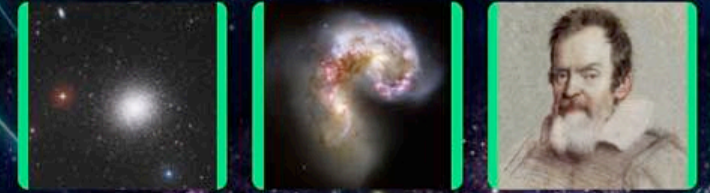
# Lotería Cósmica



INICIO

MAS JUEGOS

ACERCA DE



Interacción de  
Galaxias ¡La  
Antena!



## Proyectos Astronómicos

HAWC

TAOS II

GTM



# TAOS II

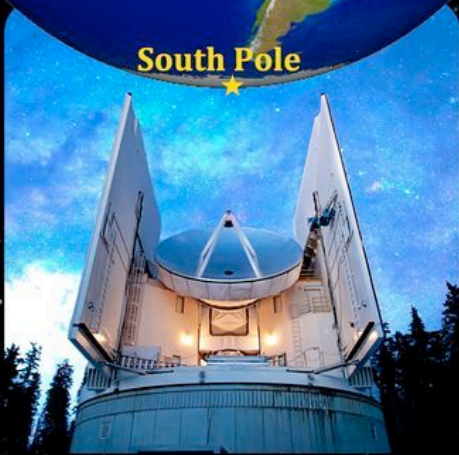
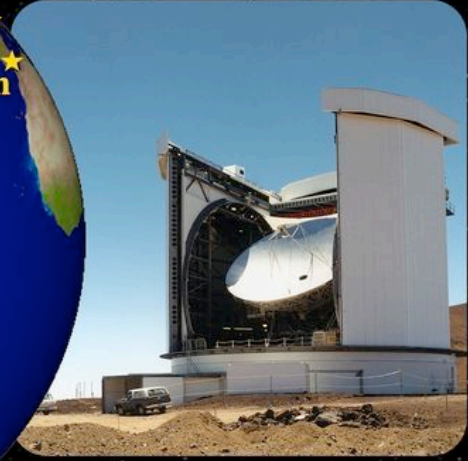
海王星外自動掩星普查計畫



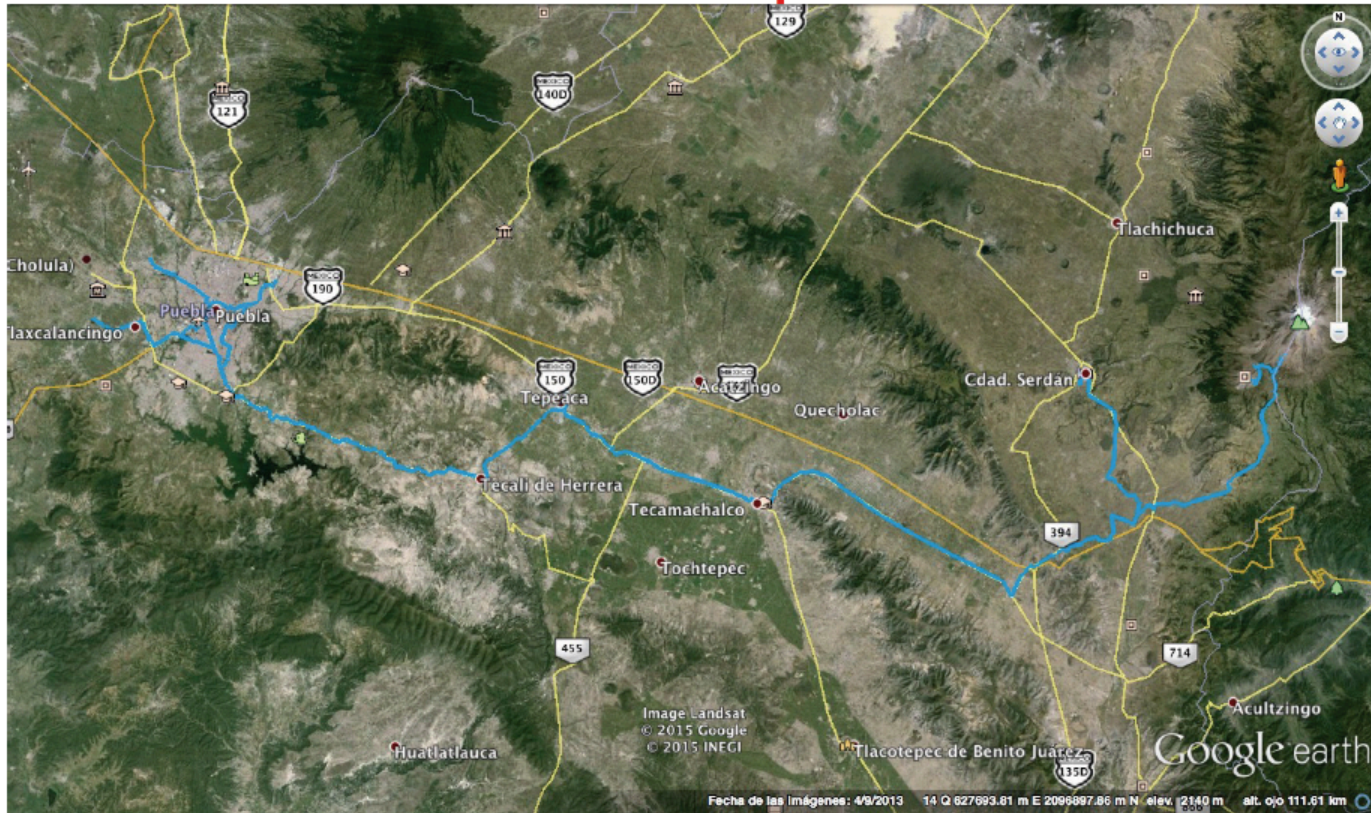
¡Problemas de  
accesibilidad  
para tendido de  
fibra óptica!



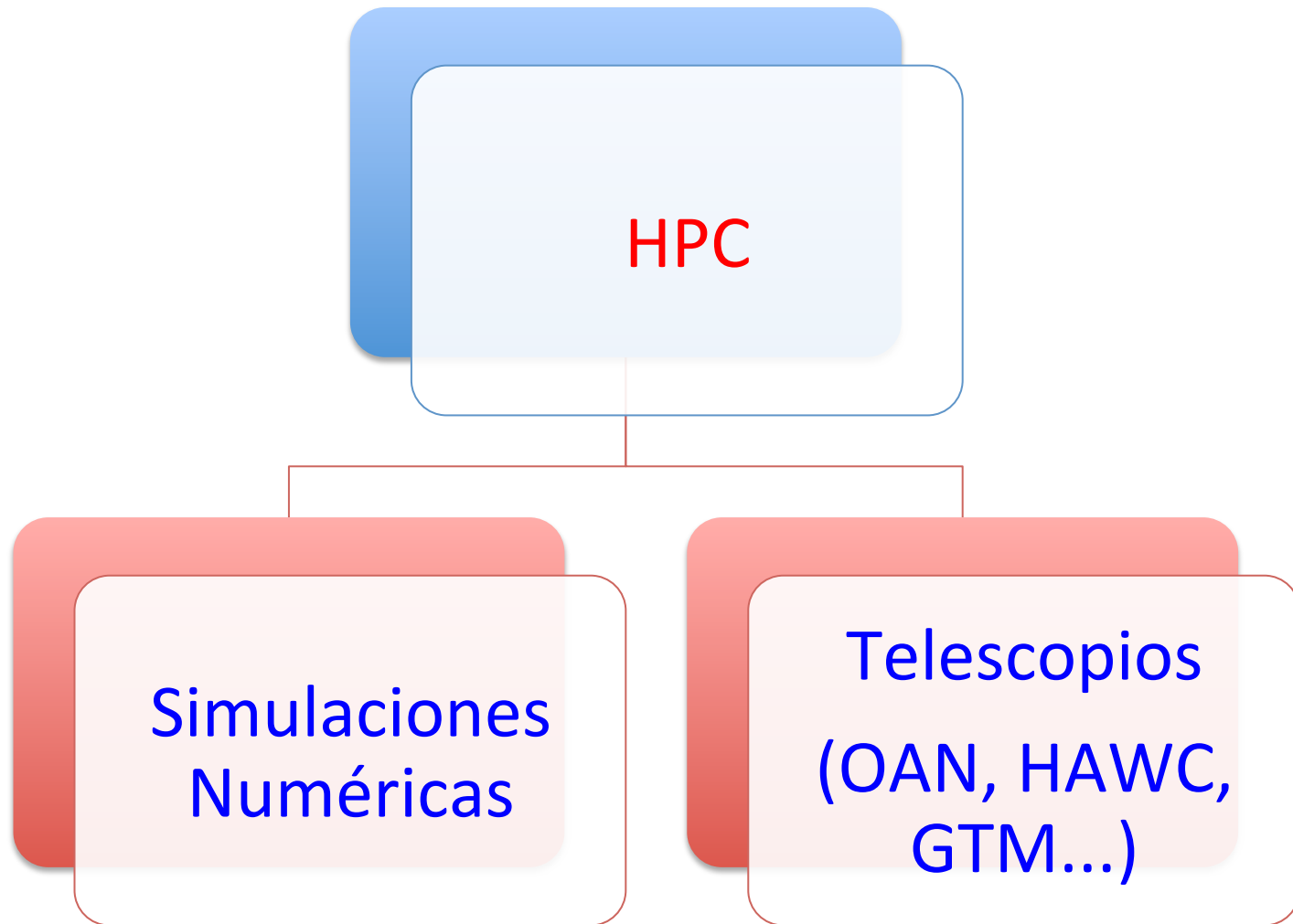
# Event Horizon Telescope



# La fibra óptica



# Supercómputo-Astrofísica

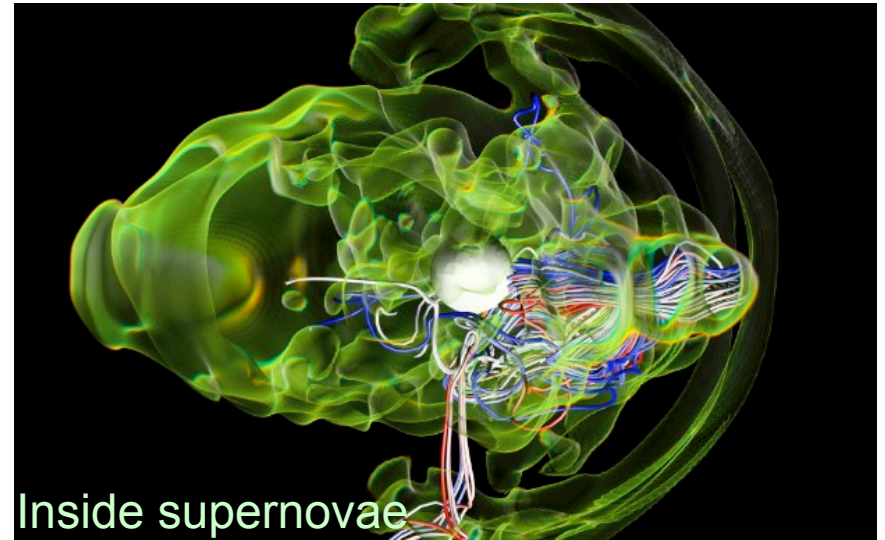
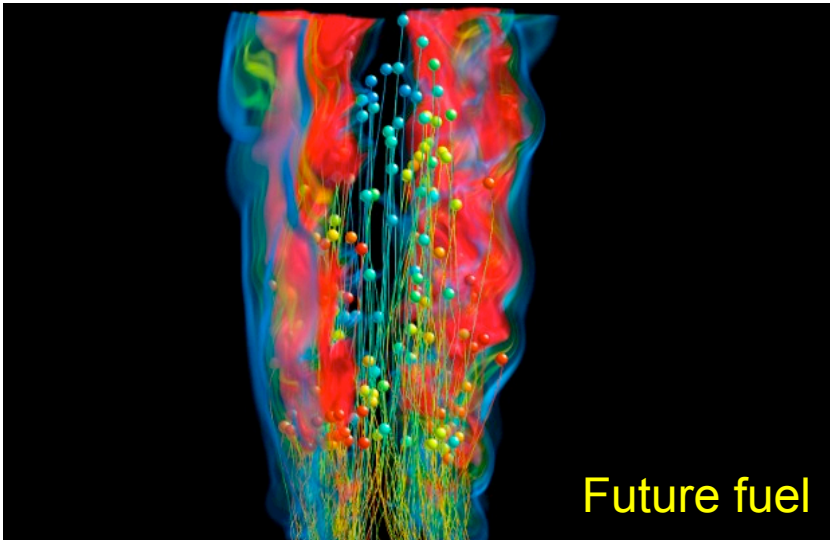
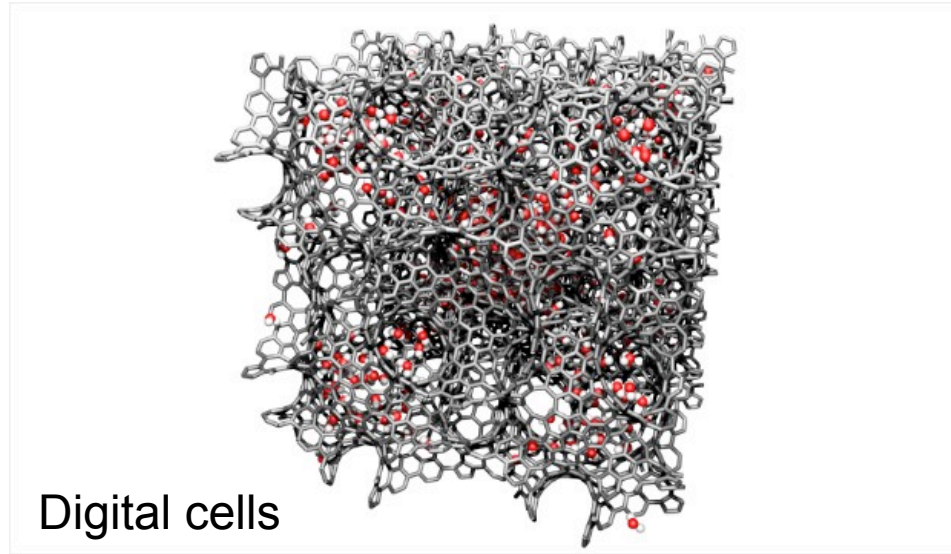
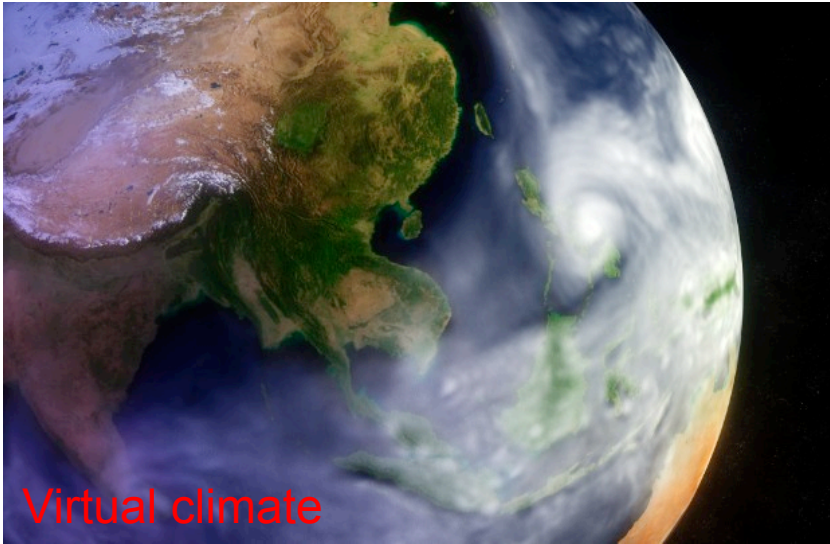






# Los 4 problemas computacionales más difíciles en la Tierra

# Supercómputo



# Antecedentes

(<http://www.revista.unam.mx/vol.0/art4/arti4.html>)

1958

Inicio del Cómputo en México  
Computadora Electrónica IBM 650  
(200 operaciones por segundo)  
Centro de Cómputo Electrónico, UNAM

1960

Arcadio Poveda (IAUNAM)  
Analizar movimientos estelares en una galaxia

1963

Renato Iturriaga (CCE-PUC)  
Análisis numérico del problema de N-cuerpos

Con estos dos trabajos da inicio la era de las Simulaciones Numéricas en la Astronomía Mexicana.

1965

Bendix G20  
(83,000 operaciones por segundo)



# Cómputo Vectorial y Paralelo

1991

CRAY-YMP 464

1a Supercomputadora de Latinoamérica

Nace el Depto. de Supercómputo-DGSCA

4P vectoriales a 133 MHz, 64 MWords de RAM

1999

CRAY-ORIGIN 2000

40 procesadores, 195 MHz y 390Mflop/s por procesador, nodos de 2P y 512MB de memoria local, 10GB de memoria RAM total.

# CRAY-YMP 464





**CRAY-YMP464**

**Congresos  
Internacionales  
HPC**

**Capacitación  
Especializada**

**Financiamiento  
Proyectos  
Científicos**

# FIRST UNAM-CRAY SUPERCOMPUTING CONFERENCE

*Franco et al. 1993*

*Numerical Simulations in Astrophysics*

*Modelling the Dynamics of the Universe*

## Topics

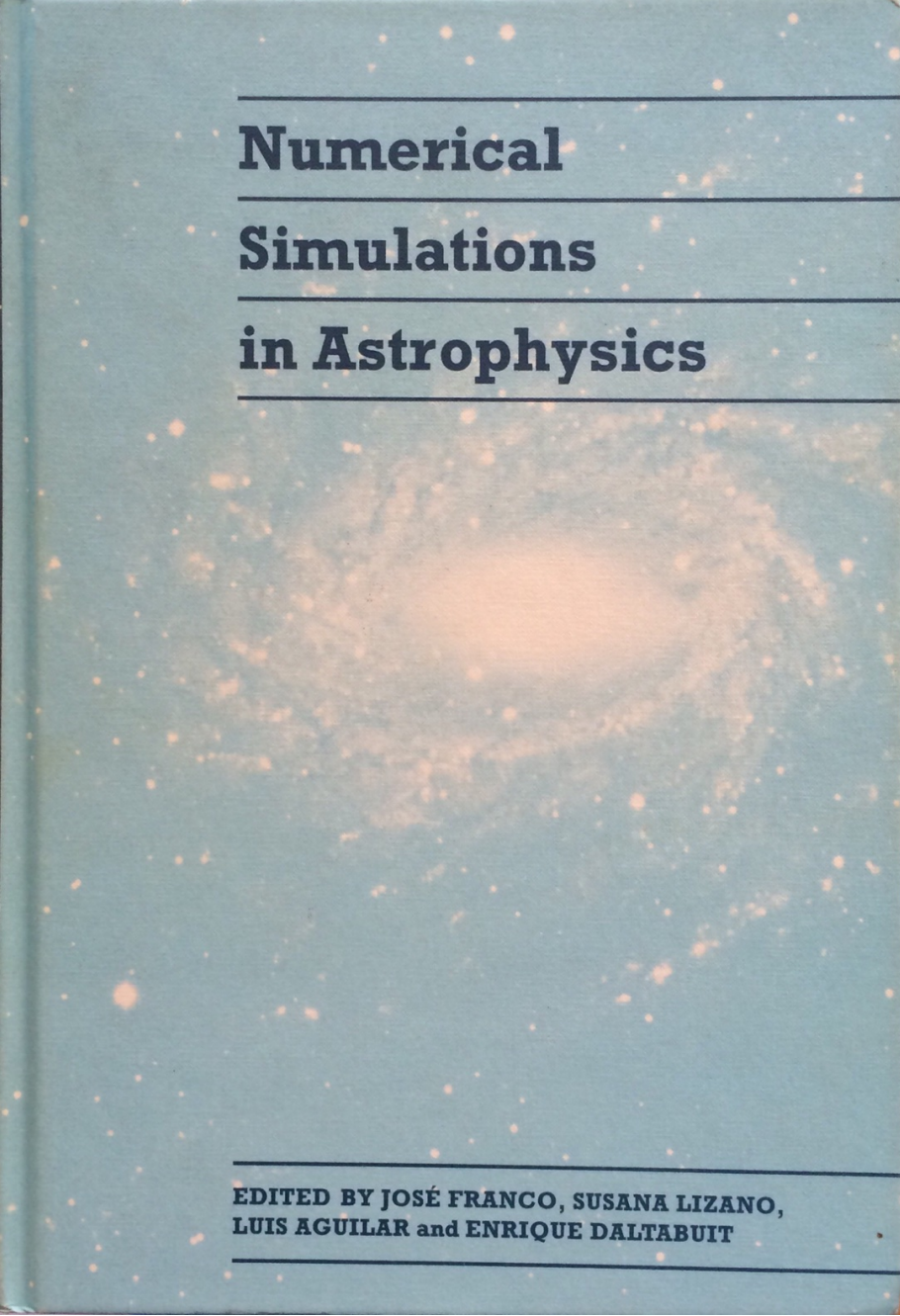
- Large Scale Structure of the Universe
  - Clusters of Galaxies
  - Galactic Systems
  - Dynamics of the ISM
  - Star Formation
- Planetary System Dynamics
  - Accretion Disks
  - Dynamics of SN Explosions



Universidad Nacional  
Autónoma de México

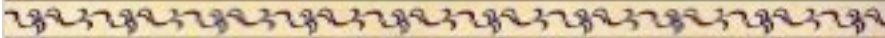


*Diseño Toña Zimerman*



**Numerical  
Simulations  
in Astrophysics**

EDITED BY JOSÉ FRANCO, SUSANA LIZANO,  
LUIS AGUILAR and ENRIQUE DALTABUIT



Numerical Simulations in  
Astrophysics. Proceedings of the  
First UNAM-CRAY Supercomputing  
Workshop, 'Numerical Simulations  
in Astrophysics: Modelling the  
Dynamics of the Universe' held in  
Mexico City, July 26-30, 1993.

Franco, Jose a. o. (Edts.)

Note: This is not the actual book cover

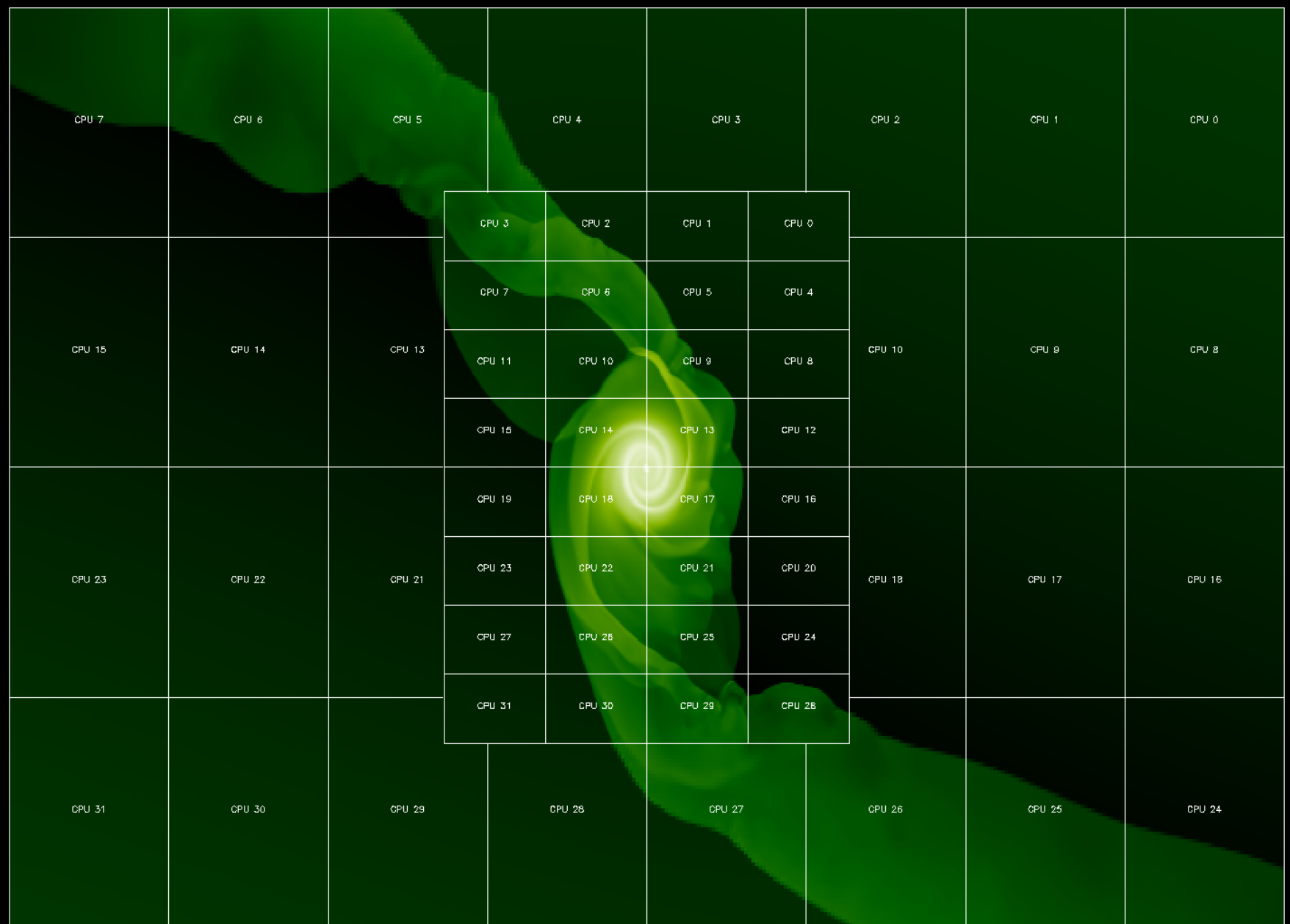




# La Era de los Clusters y la Astrofísica

# ¿Qué es el Cómputo Paralelo?

Masset 2002



- **In Mexico**, the **first Beowulf** computer built in an academic institution was "**Hormiga**", assembled by **Alberto Vela** of **CINVESTAV** in **1997-1998** (A. Vela 2002, private communication). (**10 Pentium II** processors at **233 MHz**, linked using twisted pair **Ethernet** running at **100 Mbps**.)
- The **second Beowulf** machine built in Mexico at an academic institution is the machine we describe here: "**La Granja**", built at the Ensenada branch of the Instituto de Astronomía of the National Autonomous University of Mexico (**IAUNAM**). (**32 Pentium III** processors of **450 MHz**, **Fast Ethernet** card (**10/100 Mbps**).
- As far as we know, there is only a **third Beowulf** computer built in Mexico in an academic institution. This is a **20 Pentium III** processor built at the Mexico City branch of the **IAUNAM** (**D. Page 2002**, private communication).

*Revista Mexicana de Astronomía y Astrofísica, 39, 197-205 (2003)*

## LA GRANJA: A BEOWULF TYPE COMPUTER FOR NUMERICAL SIMULATIONS IN STELLAR AND GALACTIC DYNAMICS

H. Velázquez and L. A. Aguilar

Instituto de Astronomía, UNAM, Ensenada, B. C., México

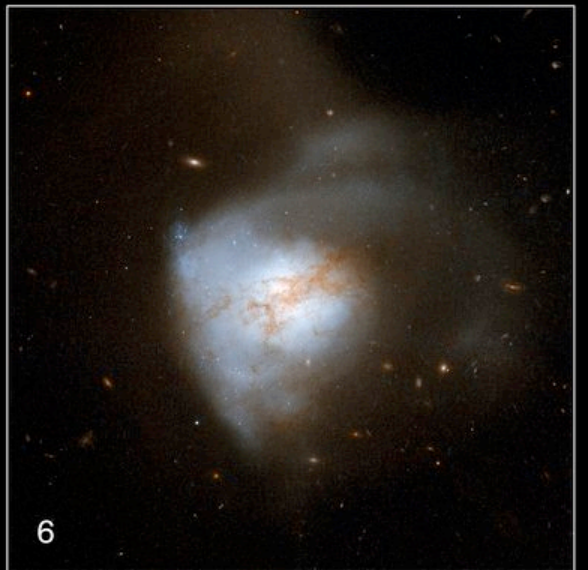
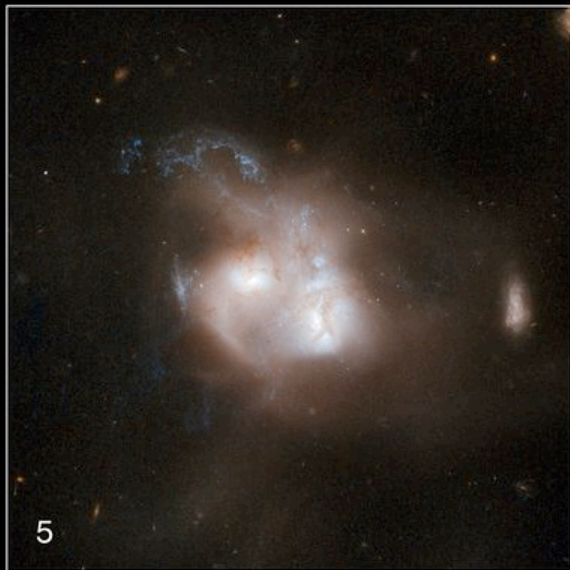
Received 2002 June 17; accepted 2003 May 14

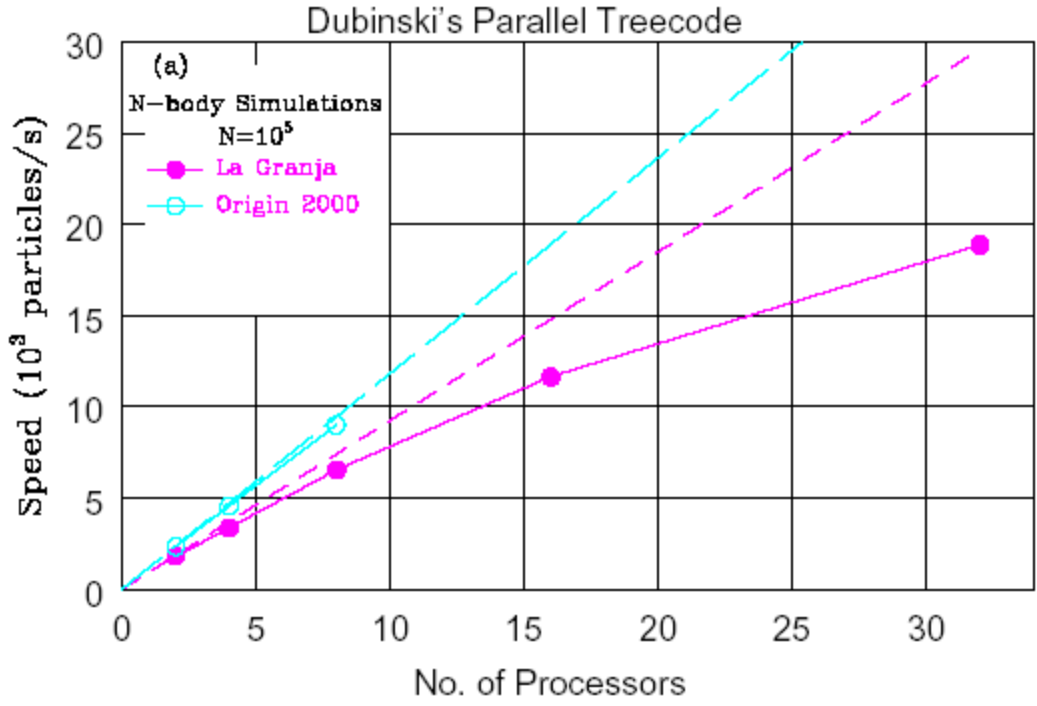
### RESUMEN

Presentamos una computadora tipo "Beowulf" construida usando componentes comerciales y programas libres. Se compara su rendimiento en capacidad de cálculo y eficiencia en computaciones paralelas con el obtenido para una computadora Origin-2000 de la compañía SGI, usando dos códigos de N-cuerpos diferentes.

Se discute el impacto de esta tecnología, que abre la posibilidad de efectuar de manera rutinaria simulaciones con alrededor de un millón de partículas con una computadora "hecha en casa". Se muestra el efecto de mayor resolución numérica con simulaciones de un colapso sin disipación frío, y del calentamiento de la componente vertical del disco de una galaxia espiral que evoluciona aisladamente.

# Problema N-Cuerpos





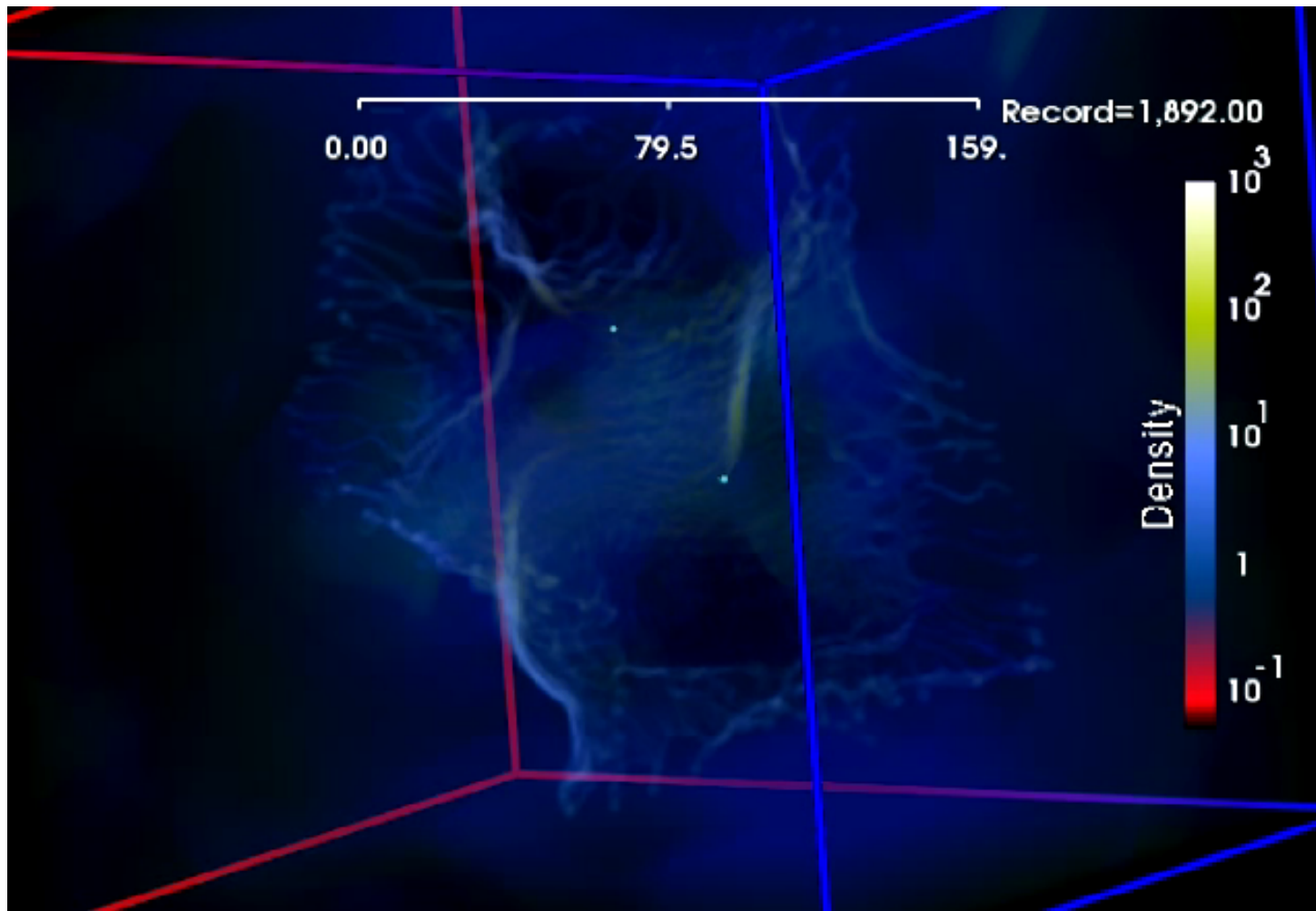


# ¡La Rebelión de la Granja!

## Molecular cloud evolution – V. Cloud destruction by stellar feedback

Pedro Colín,<sup>★</sup> Enrique Vázquez-Semadeni and Gilberto C. Gómez

*Centro de Radioastronomía y Astrofísica, UNAM, Apartado Postal 72-3 (Xangari), 58089 Morelia, Mexico*



Código: ART

CPUs: 16 cores

$T_{WC}$ : 10 días



# ISUM 2015-2016

## 1. Introductory course to parallel computing with MPI and CUDA



Frédéric Massets

*UNAM*

After a short reminder of the C language, we will introduce the basic concepts of parallel programming on distributed memory architectures with MPI (Message Passing Interface). After that we will give an introductory lecture to multithread programming on board of GPUs (Graphics Processing Units) with the CUDA language. If time allows, we will conclude with a study of hybrid parallel programming MPI+CUDA, aimed at clusters of GPUs.

Information about the workshops [here](#).

# GPUs

## Planet heating prevents inward migration of planetary cores

Pablo Benítez-Llambay, Frédéric Masset, Gloria Koenigsberger & Judit Szulágyi

[Affiliations](#) | [Contributions](#) | [Corresponding author](#)

*Nature* **520**, 63–65 (02 April 2015) | doi:10.1038/nature14277

Received 03 December 2014 | Accepted 29 January 2015 | Published online 01 April 2015

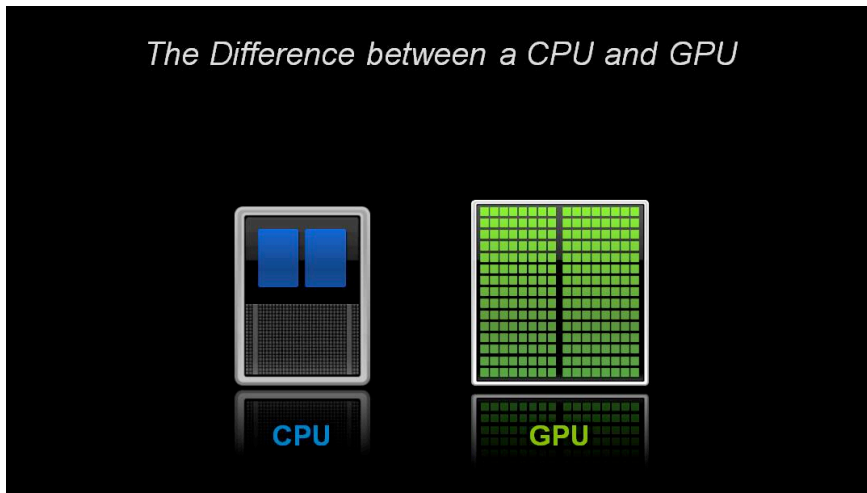
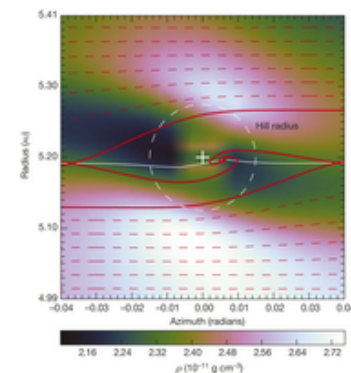
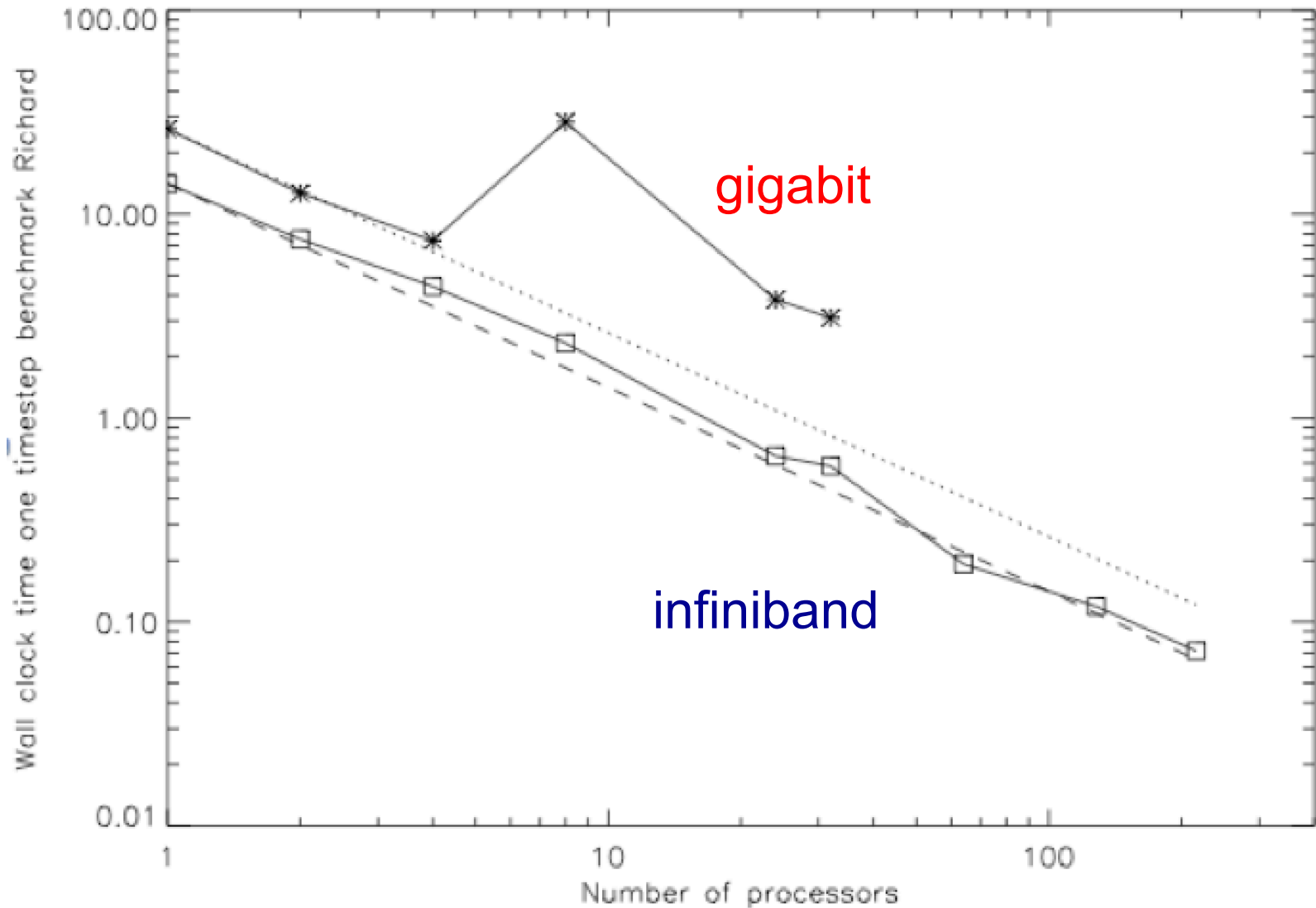


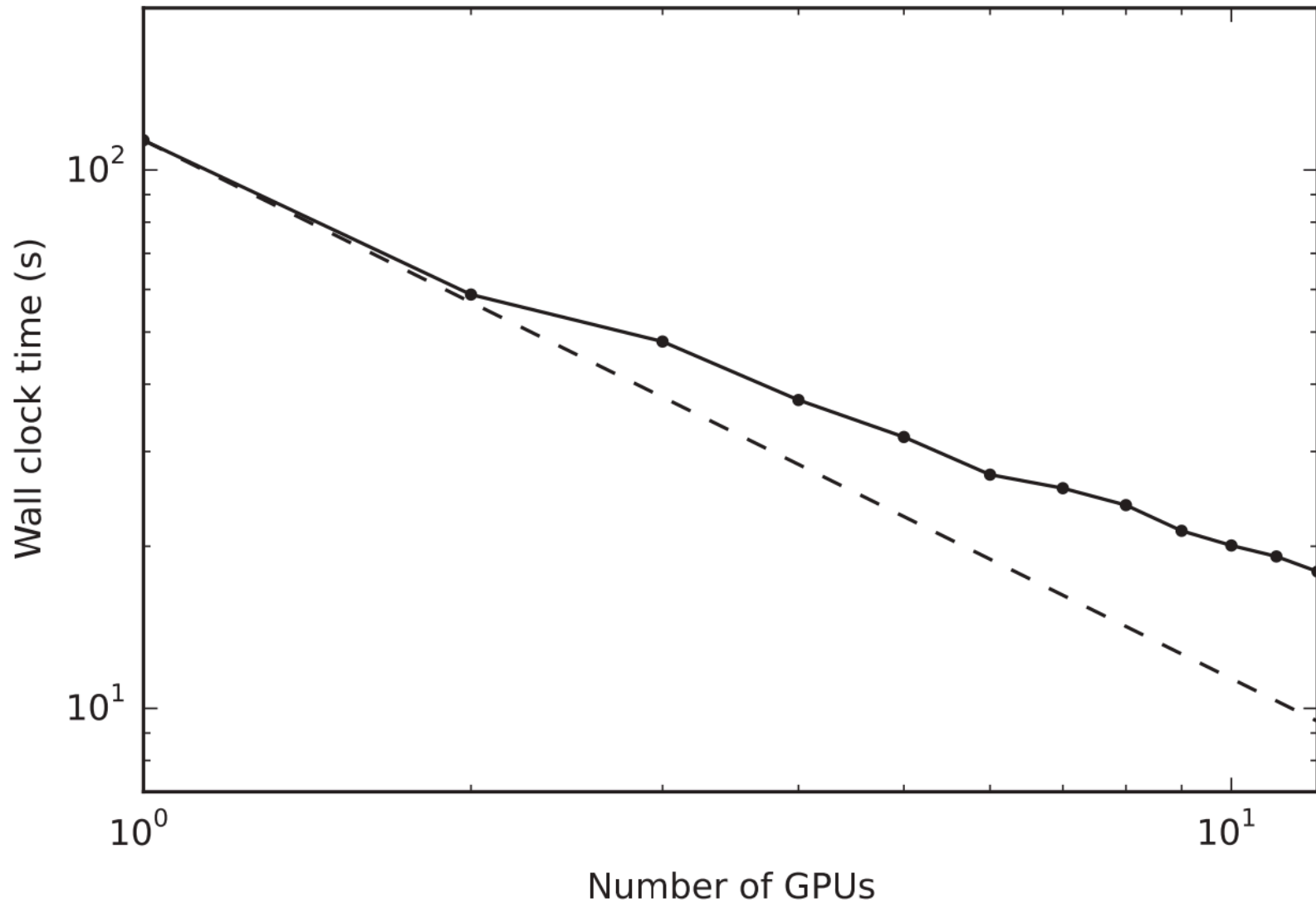
Figure 3: Density in the vicinity of an irradiating embryo.



# Rendimiento CPUs (Masset 2016)



# Rendimiento GPUs (Masset 2016)



# ISUM 2015

## 2. A practical introduction to numerical hydrodynamics



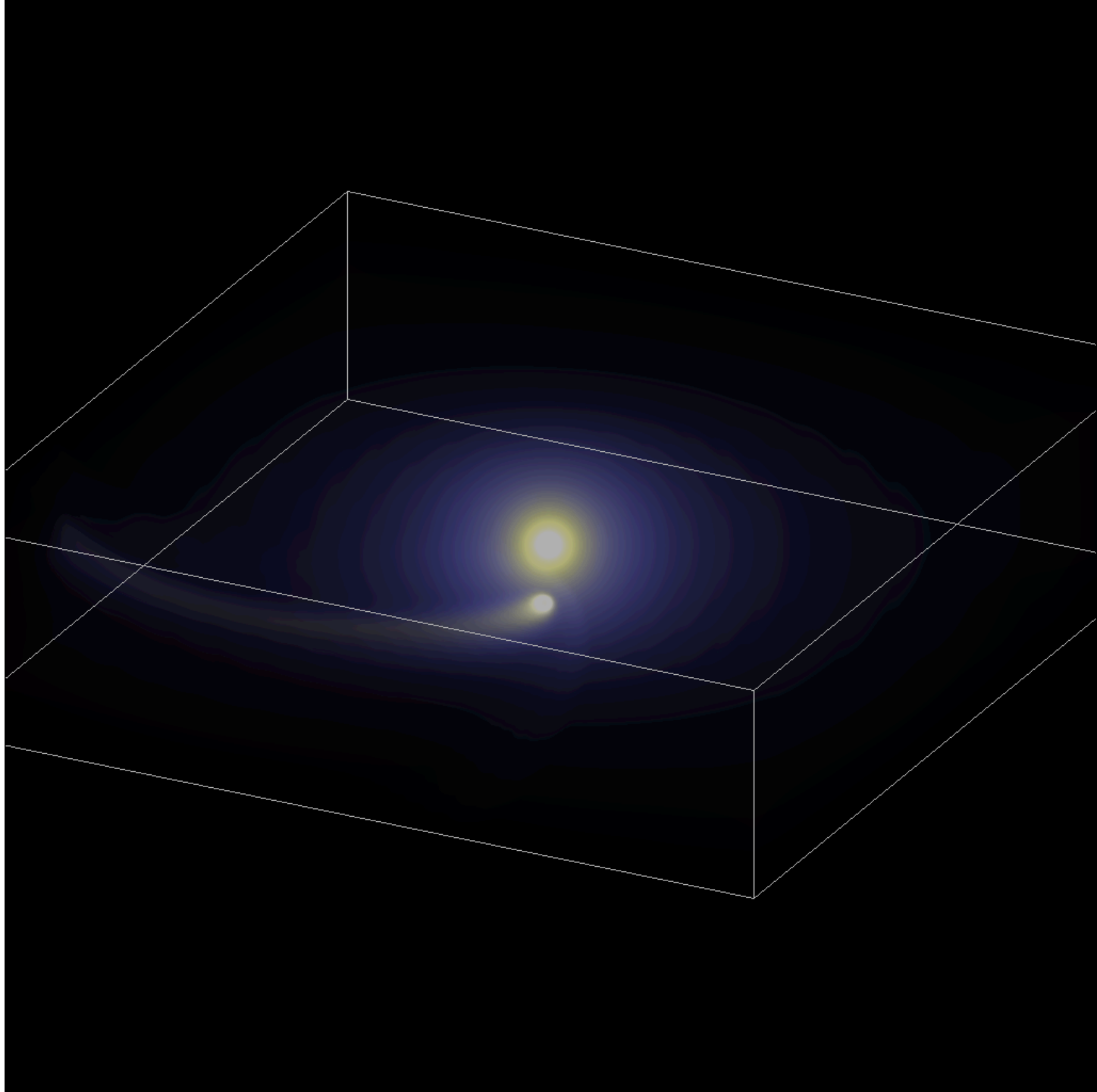
[Alejandro Esquivel](#)

*ICN-UNAM*

We will start with a general overview of hydrodynamics and its application to astrophysical fluids.

We will explore various methods of solution of the fluid dynamic equations, by finite differences or finite elements. The students will develop their own code to solve the hydrodynamic equations in 1 or 2 dimensions in a single processor. Finally we will do an introduction to MPI (Message Passing Interface) to parallelize these codes.

Information about the workshops [here](#).



# Photoionization of planetary winds: case study HD 209458b

E. M. Schneiter,<sup>1,2,3★</sup> A. Esquivel,<sup>4★</sup> C. S. Villarreal D'Angelo,<sup>1★</sup> P. F. Velázquez,<sup>4</sup>  
A. C. Raga<sup>4</sup> and A. Costa<sup>1</sup>

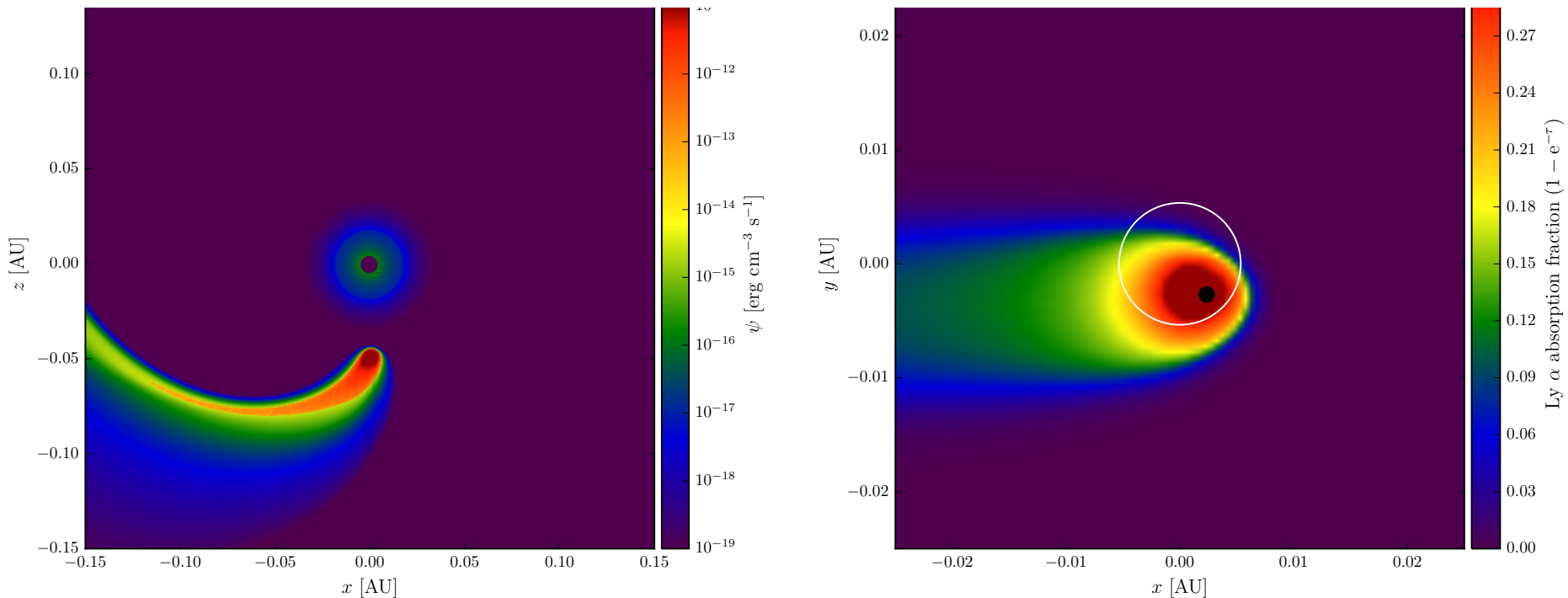
<sup>1</sup>*Instituto de Astronomía Teórica y Experimental, Universidad Nacional de Córdoba, X500BGR Córdoba, Argentina*

<sup>2</sup>*Departamento de Materiales y Tecnología, UNC, X5016GCA Córdoba, Argentina*

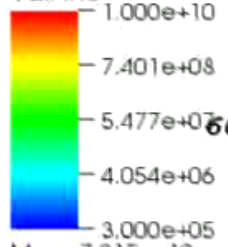
<sup>3</sup>*Department of Astronomy, AlbaNova, Stockholm University, SE-106 91 Sweden*

<sup>4</sup>*Instituto de Ciencias Nucleares, Universidad Nacional Autónoma de México, 70-543 México D. F. México*

Accepted 2016 January 8. Received 2015 December 14; in original form 2015 July 21



Pseudocolor  
DB: Blocks000.0000.vtk  
Cycle: 0  
Var: rho

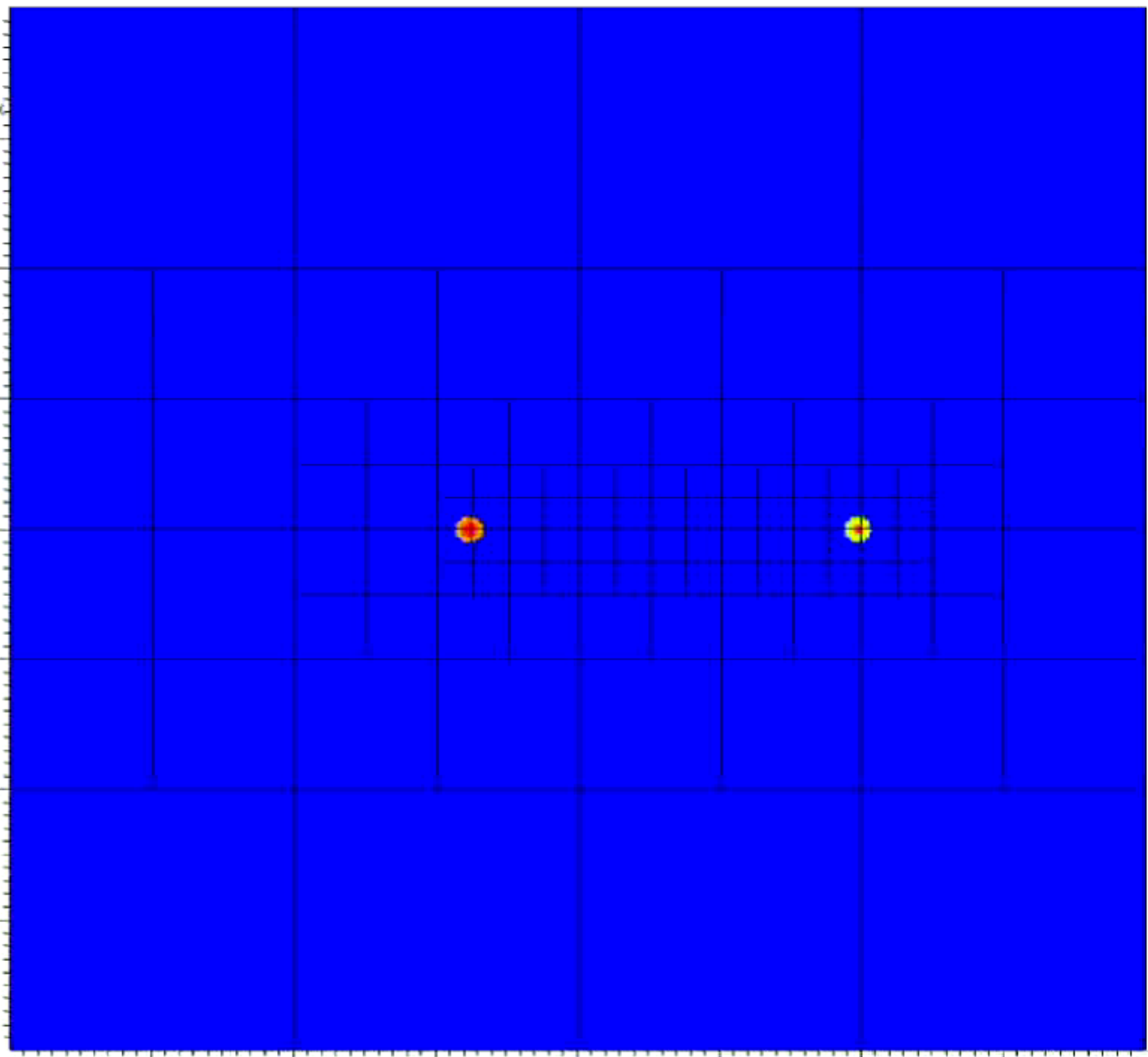


Max: 7.915e+10  
Min: 1.000

Mesh  
DB: Grid.0000.vtk  
Cycle: 0  
Var: mesh

Y-Axis

70  
60  
50  
40  
30  
20  
10



10 20 30 40 50 60 70  
X-Axis

64 cores

$T_{WC} = 7$  días



Run on supercomputers in **France, Germany & US**

The largest was run on **8,192 compute cores**, and took **19 million CPU hours**

A single state-of-the-art **desktop computer** would require more than **2000 years** to perform this calculation.

"Properties of galaxies reproduced by a hydrodynamic simulation", Vogelsberger, Genel, Springel, Torrey, Sijacki, Xu, Snyder, Bird, Nelson, Hernquist, Nature 509, 177-182 (08 May 2014) doi:10.1038/nature13316



¡GRACIAS!

[alfredo@astro.unam.mx](mailto:alfredo@astro.unam.mx)

Twitter: @ASTROPEQUE

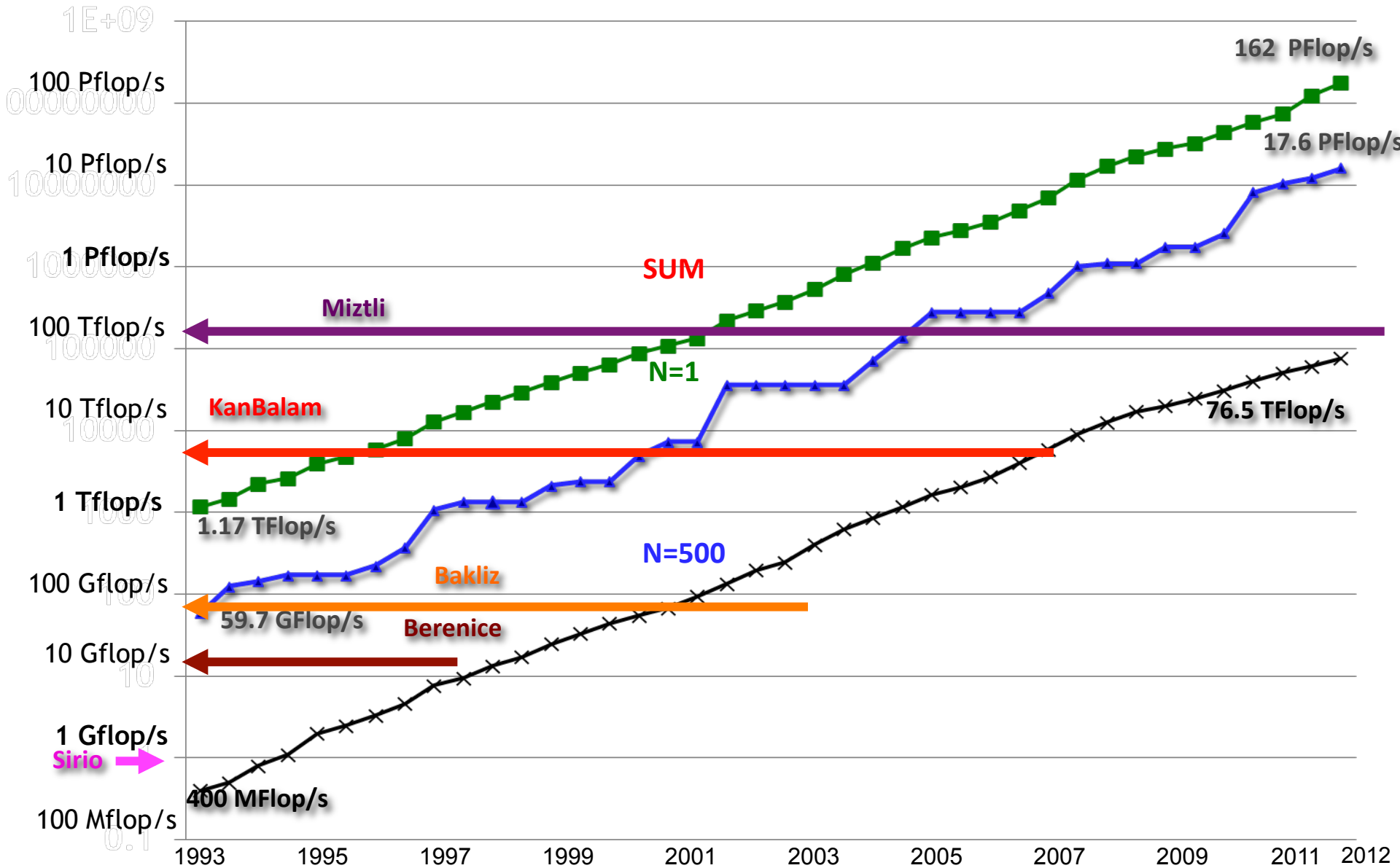


¡Nuestra Realidad!

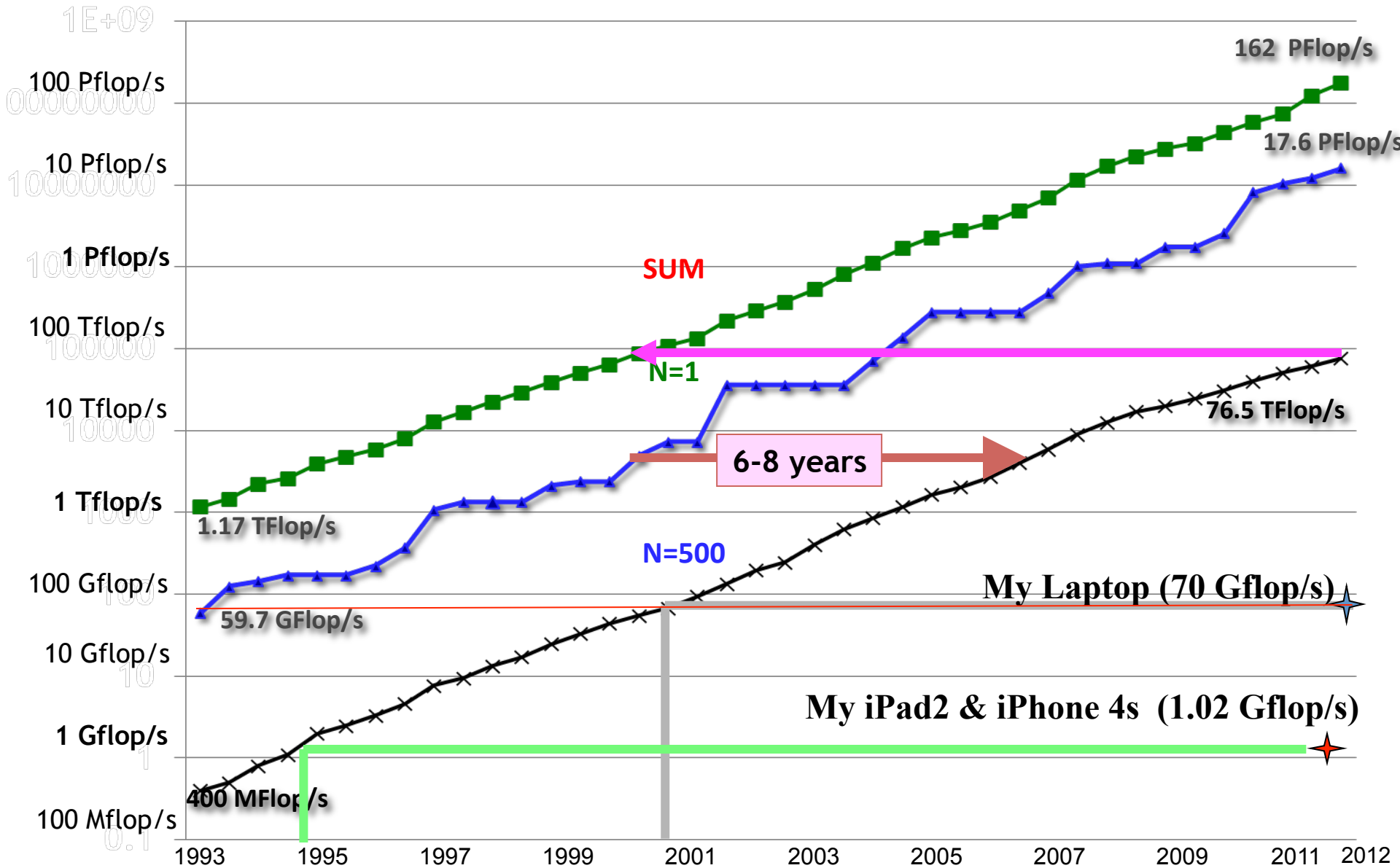
# Supercómputo UNAM

	1991	1997	2003	2007	2013
	Sirio	Berenice	Bakliz	KanBalam	Miztli
marca	CRAY	SGI	HP	HP	HP
procesador	Vectorial	R10000	Alpha EV67	Opteron Dual Core	Intel E2670 8 cores
número de procesadores	4	40	32	1,368	5,312
rendimiento numérico (GFlops)	1.02	15.6	80	7,113	118,000
memoria (Gigabytes)	0.512	10	32	3,016	23,000
almacenamiento (Gigabytes)	19	170	1,000	160,000	750,000

# Performance Development of HPC Over the Last 20 Years



# Performance Development of HPC Over the Last 20 Years



# iPhone rosita

## 7 vs 6c



### iPhone9,3-D101AP / 2 cores

Problem size:

Number of runs:

Multithread mode:

#### Run benchmark

Run: #100

Mflop/s: 1702.54

Time: 0.0986

Norm Res: 5.1700

Precision: 2.22044605e-16

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**Max Mflop/s: 1736.09**

**Avg Mflop/s: 1711.73**

### iPhone8,1-N71mAP / 2 cores

Problem size:

Number of runs:

Multithread mode:

#### Run benchmark

Run: #10

Mflop/s: 1190.66

Time: 0.1421

Norm Res: 5.1700

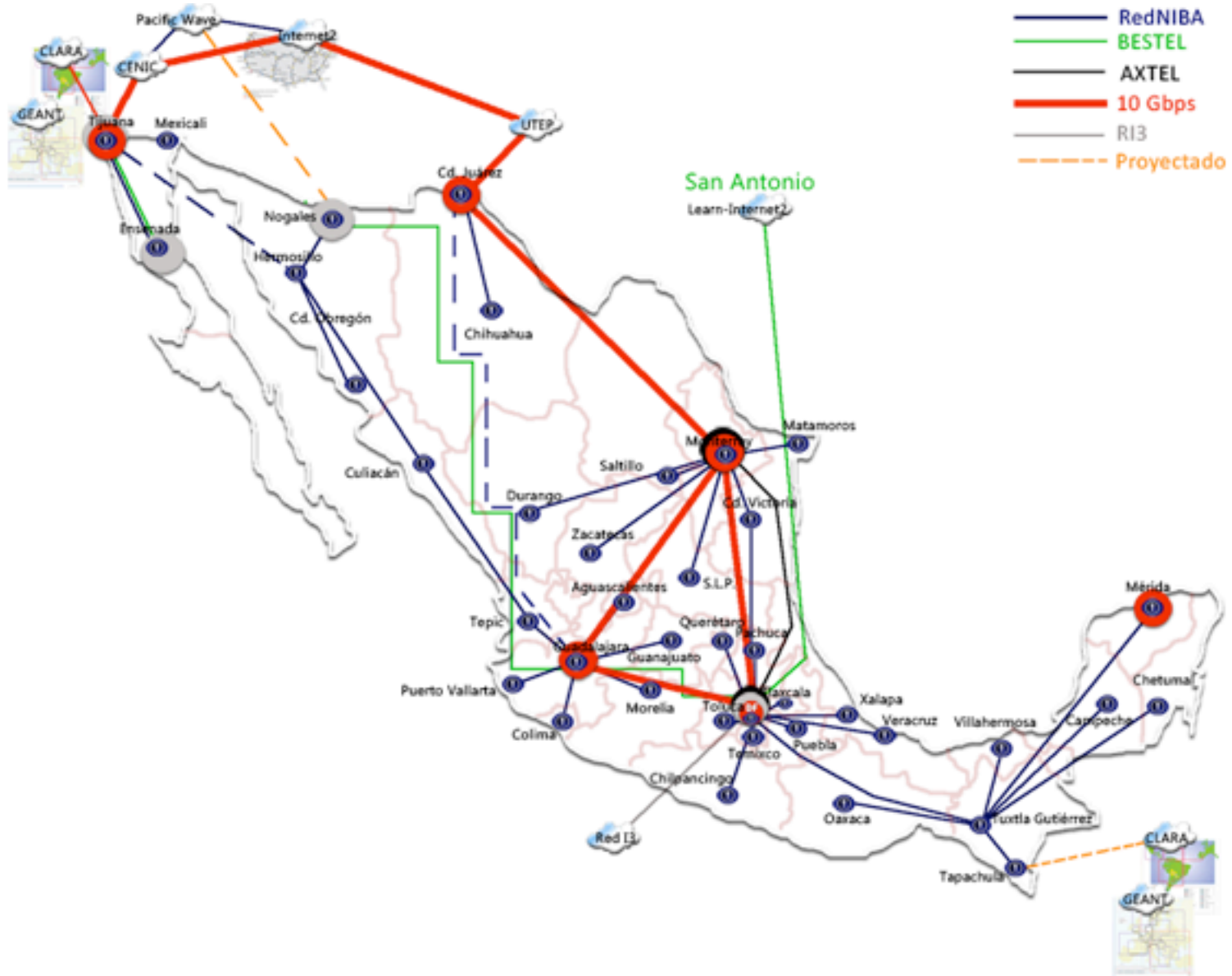
Precision: 2.22044605e-16

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**Max Mflop/s: 1281.44**

**Avg Mflop/s: 1234.72**

# Redes de Alto Rendimiento





# ¿Son Supercomputadoras?



# ¿Son Supercomputadoras?

