



# Application to the science

*S. Honda, Y. Shirasaki, M. Tanaka  
and JVO team*

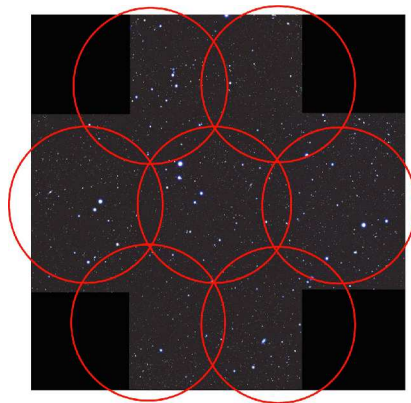
*National Astronomical Observatory of Japan*

# The development plan of JVO

- JVO develops for a few limited science scenarios, and it expands for other science scenarios.
- The required functions are probed and added.

# Scientific target on JVO prototype 2

- Cross match of the optical and X-ray catalogs and image retrievals.
- Search for gravitational lens objects.
  - A phenomenon that the space-time is distorted by a huge mass object, and multiple images of another object behind the massive object are observed around it.
- SDF and SXDS data observed by Subaru are used.



# Work flow for Gravitational lens search

1. Retrieve Subaru catalog data in a specified region.
2. Calculate brightness.
3. Define condition to select quasars.
4. Make a list of pair quasar objects.
5. Retrieve image data of the pair objects.
6. Narrow candidates by analyzing the image data.

# User Authentication

User login page.



Firefox - Login - Mozilla

ファイル(F) 編集(E) 表示(V) 移動(G) ブックマーク(B) ツール(T) ウィンドウ(W) ^

Username:

Password:

Observation Name:

**JVO**  
JAPANESE VIRTUAL OBSERVATORY

# JVO QL Editor

Query condition can be specified on this web form.

Mozilla  
ファイル(E) 編集(E) 表示(V) 移動(G) ブックマーク(B) ツール(T) ウィンドウ(W) ヘルプ(H)  
Logon| Status| **DB Search** | Search| Analysis| Display

## JVO Query Language Editor

User = yshirasa Current Observation Name = 0514  
Total memory = 266403kB Used memory = 149977kB (56%)

### 0. SQL Editor

Editor| Catalog| Region| Wavelength| Time| Image| Spectrum| Xmatch| Output

**Create SQL**

**Search**

Reset **Create SQL** **Send SQL** 参照... Load SQL

#### 1. Region Selection

Editor| Catalog| Region| Wavelength| Time| Image| Spectrum| Xmatch| Output

- Enter Position : coord1 =  coord2 =  RA-DEC  FK5
- Enter Object Name  Name Resolver
- Enter Region Size  in Radius  arcmin  in Box width/height  arcmin

#### 2. Catalog Selection

Editor| Catalog| Region| Wavelength| Time| Image| Spectrum| Xmatch| Output

- Show all the available catalogs :
- Frequently Used Catalogs :  Request Catalog(s)
- Search Catalog :

#### 3. Search with VOTable

Editor| Catalog| Region| Wavelength| Time| Image| Spectrum| Xmatch| Output

- Select VOTable :

Mozilla  
ファイル(E) 編集(E) 表示(V) 移動(G) ブックマーク(B) ツール(T) ウィンドウ(W) ヘルプ(H)  
Select VOTable :  
  
VOTable

#### 4. Wavelength Range

Editor| Catalog| Region| Wavelength| Time| Image| Spectrum| Xmatch| Output

- Set Wavelength Range ?  Yes  No
- Wavelength Lower Bound :  nm
- Wavelength Upper Bound :  nm

#### 5. Image Retrieval

Editor| Catalog| Region| Wavelength| Time| Image| Spectrum| Xmatch| Output

- Retrieve Image ?  Yes  No
- Coordinate:  
 coord1 =  coord2 =  RA-DEC  FK5   
 coord1 =  coord2 =
- Enter Image Size (box size):  arcsec

#### 6. Spectrum Retrieval

Editor| Catalog| Region| Wavelength| Time| Image| Spectrum| Xmatch| Output

- Retrieve Spectrum ?  Yes  No

#### 7. Observation Period

Editor| Catalog| Region| Wavelength| Time| Image| Spectrum| Xmatch| Output

- Set Observation Period ? :  Yes  No

	Year	Mon.	Day	Hour	Min.	Sec
From	1900	1	1	0	0	0
To	2100	1	1	0	0	0

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# DB Search

JVO DB Search - Mozilla

ファイル(E) 編集(E) 表示(V) 移動(G) ブックマーク(B) ツール(T) ウィンドウ(W) ヘルプ(H)

[Logon](#) | [Status](#) | [DB Search](#) | [Search](#) | [Analysis](#) | [Display](#)

## DB Search

User = yshirasa Current Observation Name = demo

Total memory = 266403kB Used memory = 150330kB (56%)

### Simple Search

Submit

**Wavelength:**  Gamma-ray  X-ray  Optical  IR  sub-mm  Radio  others

**Telescope:**  Subaru  SDSS  2MASS  XMM  others

### Advanced Search

Submit

Title	<input type="text"/>
Subject	<input type="text"/>
Description	<input type="text"/>
Facility	<input type="text"/>
Instrument	<input type="text"/>
RA of Center	<input type="text"/>
Dec of Center	<input type="text"/>
Size of Region	<input type="text"/>
Spectral Band	<input type="text"/>
Spectral Wavelength	Min = <input type="text"/> Max = <input type="text"/>



Mozilla

ファイル(E) 編集(E) 表示(V) 移動(G) ブックマーク(B) ツール(T) ウィンドウ(W) ヘルプ(H)

[Logon](#) | [Status](#) | [DBSearch](#) | [Search](#) | [Analysis](#) | [Display](#)

[Catalog Search](#) | [Catalog List](#)

## Catalog List

User = yshirasa Current Observation Name = demo

Total memory = 266403kB Used memory = 158278kB (59%)

Title	Description
<a href="#">XMM-Newton Deep Survey</a>	The XMM-Newton Deep Survey.
<a href="#">Sloan Digital Sky Survey</a>	Sloan Digital Sky Survey (TEST)
<a href="#">Subaru/XMM-Newton Deep Survey 01</a>	The Subaru/XMM-Newton Deep Survey (SXDS) is a major new multi-wavelength survey of a ~1 square degree region of sky.
<a href="#">Subaru Deep Field z'-band</a>	The Subaru Deep Field z'-band Catalog (TEST)
<a href="#">Subaru Deep Field I'-band</a>	The Subaru Deep Field I'-band Catalog (TEST)



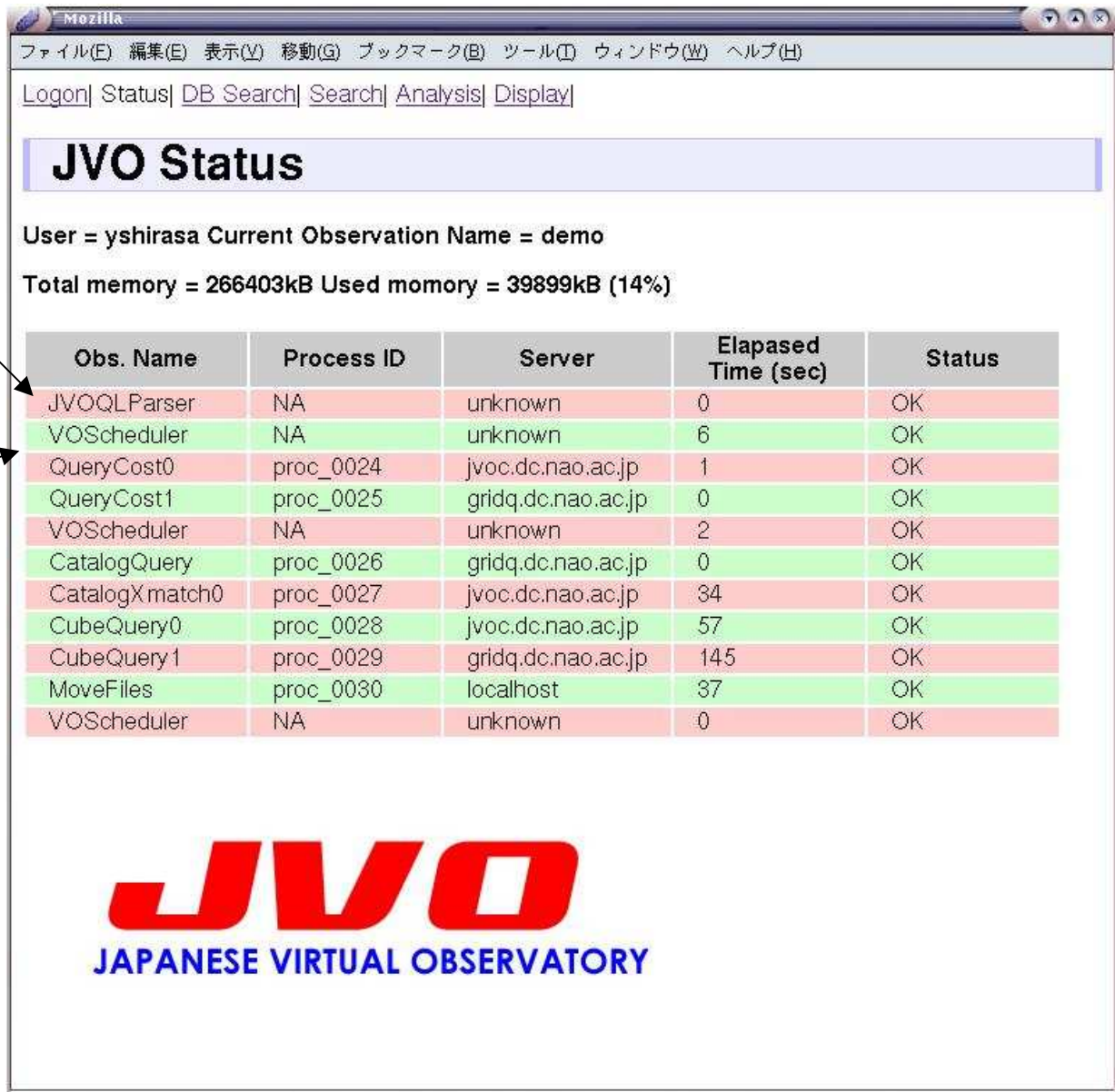
Registry is used to find available data.



# Search Status

JVOQL parser  
decomposes JVOQL.

Scheduler generates  
work flow, and  
Executer performs  
remote procedure  
calls.



Firefox

ファイル(E) 編集(E) 表示(V) 移動(G) ブックマーク(B) ツール(T) ウィンドウ(W) ヘルプ(H)

Logon| Status| DB Search| Search| Analysis| Display|

## JVO Status

User = yshirasa Current Observation Name = demo

Total memory = 266403kB Used memory = 39899kB (14%)

Obs. Name	Process ID	Server	Elapased Time (sec)	Status
JVOQLParser	NA	unknown	0	OK
VOScheduler	NA	unknown	6	OK
QueryCost0	proc_0024	fvoc.dc.nao.ac.jp	1	OK
QueryCost1	proc_0025	gridq.dc.nao.ac.jp	0	OK
VOScheduler	NA	unknown	2	OK
CatalogQuery	proc_0026	gridq.dc.nao.ac.jp	0	OK
CatalogXmatch0	proc_0027	fvoc.dc.nao.ac.jp	34	OK
CubeQuery0	proc_0028	fvoc.dc.nao.ac.jp	57	OK
CubeQuery1	proc_0029	gridq.dc.nao.ac.jp	145	OK
MoveFiles	proc_0030	localhost	37	OK
VOScheduler	NA	unknown	0	OK

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# Search result

Cross match of the optical and X-ray catalogs and image retrievals.

This is a kind of VOTable viewer and provides an easy access to both the table and image data.

Column attributes are displayed by pushing the "column\_info" button, where you can also control the column layout.

The screenshot shows a web browser window displaying a VOTable Viewer. The interface includes a navigation bar with 'Status', 'DB Search', 'Search', 'Analysis', and 'Display' links. Below this is the title 'VOTable Viewer' and a file path. There are buttons for 'Update', 'Next Page', a dropdown for '20 records in a page', and a circled 'Color' button. Below the controls are tabs for 'Show All Figs', 'No Figs', and 'Update All Figs'. The main content is a table with columns: Num., ra\_x, dec\_x, naoj.xmm.xmm\_erp\_B, mag\_R, mag\_i, mag\_z, FITS\_name, FITS\_name, and Image/Spectrum View. The table contains four rows of data, each with associated FITS file names and small image thumbnails. The 'Image/Spectrum View' column has a dropdown menu with options like 'small' and 'ShowPic'.

Num.	ra_x	dec_x	naoj.xmm.xmm_erp_B	mag_R	mag_i	mag_z	FITS_name	FITS_name	Image/Spectrum View	
0	34.473897	-4.96303	0.01997	319	20.4388	20.4734	20.3797	sxdsB1c_0.fits sxdsR1c_0.fits sxdsI1c_0.fits sxdsz1c_0.fits	xmm 1 02:17:53.7480 -04:57:47.4600 0.0056x0.0056.fits xmm 2 02:17:53.7480 -04:57:47.4600 0.0056x0.0056.fits xmm 3 02:17:53.7480 -04:57:47.4600 0.0056x0.0056.fits xmm 4 02:17:53.7480 -04:57:47.4600 0.0056x0.0056.fits	small ShowPic
1	34.451548	-5.005979	0.011354	155	23.6874	23.53	23.3353	sxdsB1c_1.fits sxdsR1c_1.fits sxdsI1c_1.fits sxdsz1c_1.fits	xmm 1 02:17:48.1700 -05:00:22.3600 0.0056x0.0056.fits xmm 2 02:17:48.1700 -05:00:22.3600 0.0056x0.0056.fits xmm 3 02:17:48.1700 -05:00:22.3600 0.0056x0.0056.fits xmm 4 02:17:48.1700 -05:00:22.3600 0.0056x0.0056.fits	NoShowPic
2	34.451548	-5.005979	0.011354	172	22.2287	22.0682	21.5253	sxdsB1c_2.fits sxdsR1c_2.fits sxdsI1c_2.fits sxdsz1c_2.fits	xmm 1 02:17:48.3960 -05:00:21.9900 0.0056x0.0056.fits xmm 2 02:17:48.3960 -05:00:21.9900 0.0056x0.0056.fits xmm 3 02:17:48.3960 -05:00:21.9900 0.0056x0.0056.fits xmm 4 02:17:48.3960 -05:00:21.9900 0.0056x0.0056.fits	NoShowPic
3	34.527112	-5.012024	0.007021	837	23.9466	23.516	23.2256	sxdsB1c_3.fits sxdsR1c_3.fits sxdsI1c_3.fits sxdsz1c_3.fits	xmm 1 02:18:06.7850 -05:00:41.7500 0.0056x0.0056.fits xmm 2 02:18:06.7850 -05:00:41.7500 0.0056x0.0056.fits xmm 3 02:18:06.7850 -05:00:41.7500 0.0056x0.0056.fits xmm 4 02:18:06.7850 -05:00:41.7500 0.0056x0.0056.fits	NoShowPic

# Analysis tools for Gravitational lens search

The screenshot shows a web browser window titled "Mozilla" with a menu bar in Japanese. The main content area is titled "Gravitational Lens Search" and displays user information: "User = yshirasa Current Observation Name = demo" and "Total memory = 266403kB Used memory = 128111kB (48%)".

**0. VOTable Selection**

Editor | Catalog | Image | Output | Condition

- Select VOTable :  
/home/ys Shirasa/jvo/jvo\_dev2/jvop2/work/ys Shirasa/demo/proc\_0031/catalog-out.xml  
Select

**1. Selection Conditions**

Editor | Catalog | Image | Output | Condition

- Separation angle  
10.0 arcsec
- Brightness Difference  
B 1  
R 1  
i 1  
z 1
- Color Difference  
R-B 0.1  
i-B 0.1  
z-B 0.1  
i-R 0.1  
z-R 0.1  
z-i 0.1
- Parameter Range

## lens search

GL search can be carried out using the VOTable of search result.

Select VOTable.

Select pair objects of similar color.

It is easy to add new analysis tools for conducting particular science.

YO: Gravitational Lens Search Bode Image, SED, C-plot - Mozilla (build ID: 2002032803)

ファイル(F) 編集(E) 表示(V) 検索(S) 移動(G) ブックマーク(B) タスク(T) ヘルプ(H)

**ID = 71762, 71852**

**Image**

sxdsB1c\_6.fits   C R G B   sxdsR1c\_6.fits   C R G B   sxdsz1c\_6.fits   C R G B

**Combine the three color images.**

RGB-71762.jpg

**Plot the photo z, color.**

**Data**

**Magnitude**

object ID	sxdsB1, N18APMAGB, A	sxdsB1, N18APMAGR, A	sxdsB1, N18APMAGI, A	sxdsB1, N18APMAGZ, A
71762	24.840	24.649	24.695	24.679
71852	24.802	24.680	24.755	24.672

**Color**

object ID	sxdsB1, N18APMAGB, A - sxdsB1, N18APMAGR, A	sxdsB1, N18APMAGR, A - sxdsB1, N18APMAGI, A	sxdsB1, N18APMAGI, A - sxdsB1, N18APMAGZ, A	sxdsB1, N18APMAGZ, A - sxdsB1, N18APMAGR, A
71762	0.191	0.000	0.046	0.030
71852	0.122	0.000	0.075	-0.008

2002032803

表示(V) 検索(S) 移動(G) ブックマーク(B) タスク(T) ヘルプ(H)

http://localhost:8080/yo/servlet/ShowResult

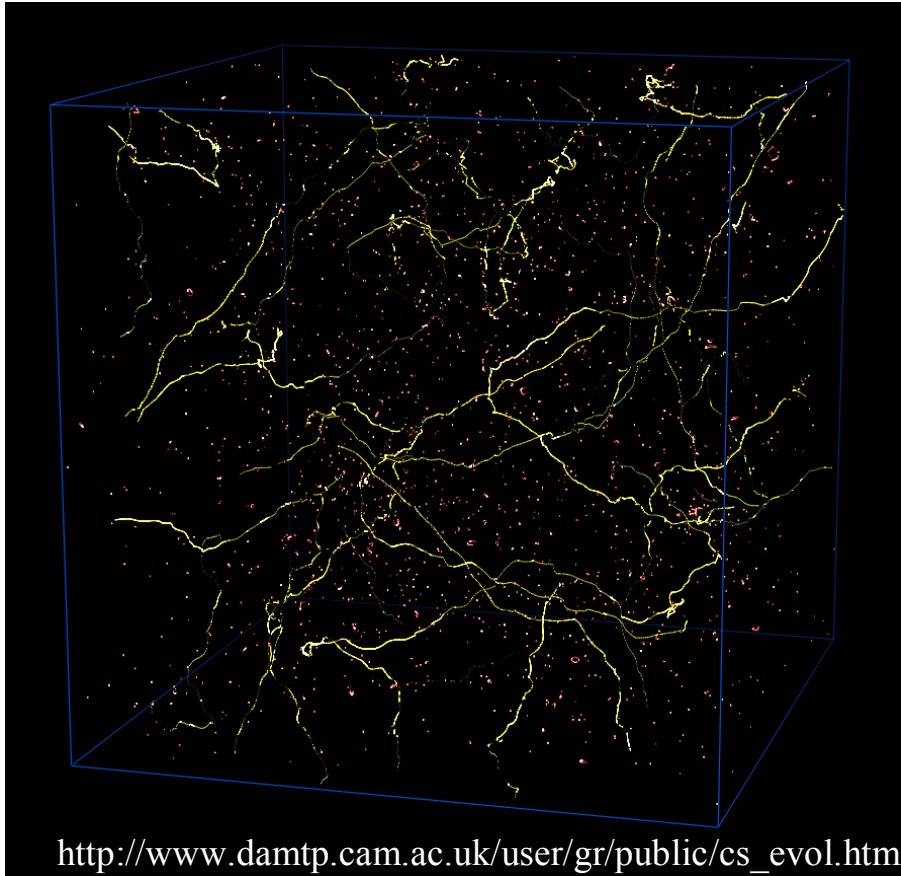
separation	FITS_name	jpg	plot
2,713	sxdsB1c_0.fits sxdsR1c_0.fits sxdsz1c_0.fits	show 	More 0 show
5,893	sxdsB1c_1.fits sxdsR1c_1.fits sxdsz1c_1.fits	show 	More 1 show
5,993	sxdsB1c_2.fits sxdsR1c_2.fits sxdsz1c_2.fits	show 	More 2 show
1,080	sxdsB1c_3.fits sxdsR1c_3.fits sxdsz1c_3.fits	show 	More 3 show
2,707	sxdsB1c_4.fits sxdsR1c_4.fits sxdsz1c_4.fits	show 	More 4 show
5,718	sxdsB1c_5.fits	show 	More 5 show

ドキュメント: 完了 (11.063 秒)

# The science target in prototype 3

- Cosmic String Search through the gravitational lens effect.
- Environmental dependence of QSO evolution.
- Automatic classification of late type star.
- Search for very metal-poor stars.
- etc.

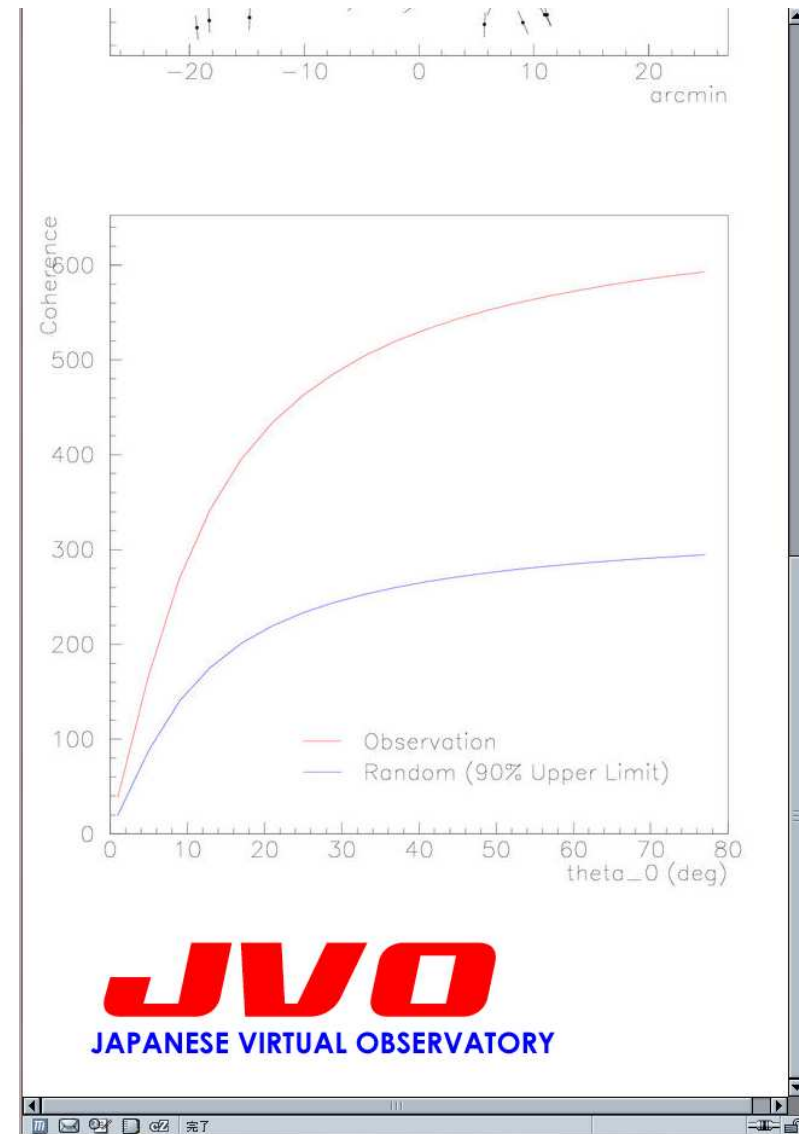
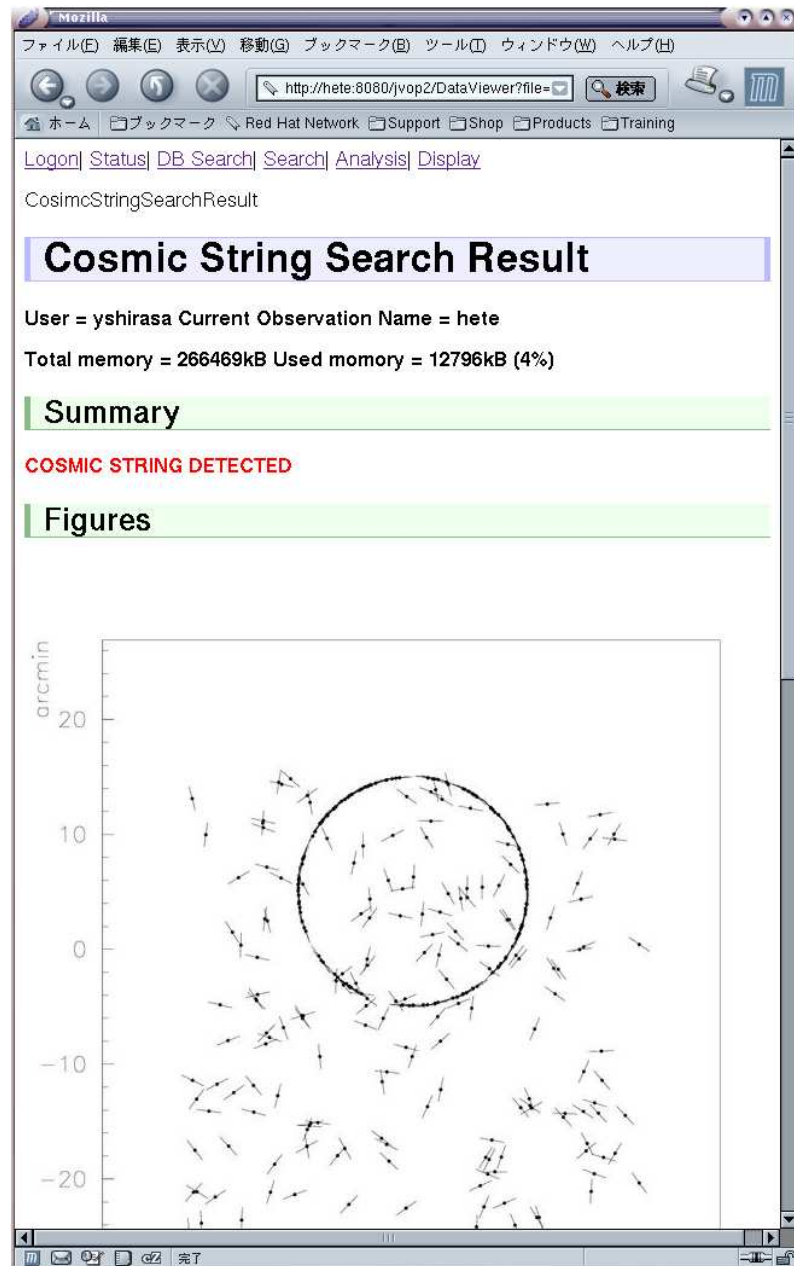
# Cosmic String



- Prediction by Unified theory
  - super heavy cosmic strings with linear mass density of  $10^{22}$  g/cm in the early universe.
- The lens effect by a long cosmic string
  - undistorted lensed image
  - co-aligned in a direction of string network
  - distributed in a very large scale.
- Because of its large scale nature, wide field deep survey is crucial for its discovery. → **Data mining from Subaru Suprime-Cam image data**

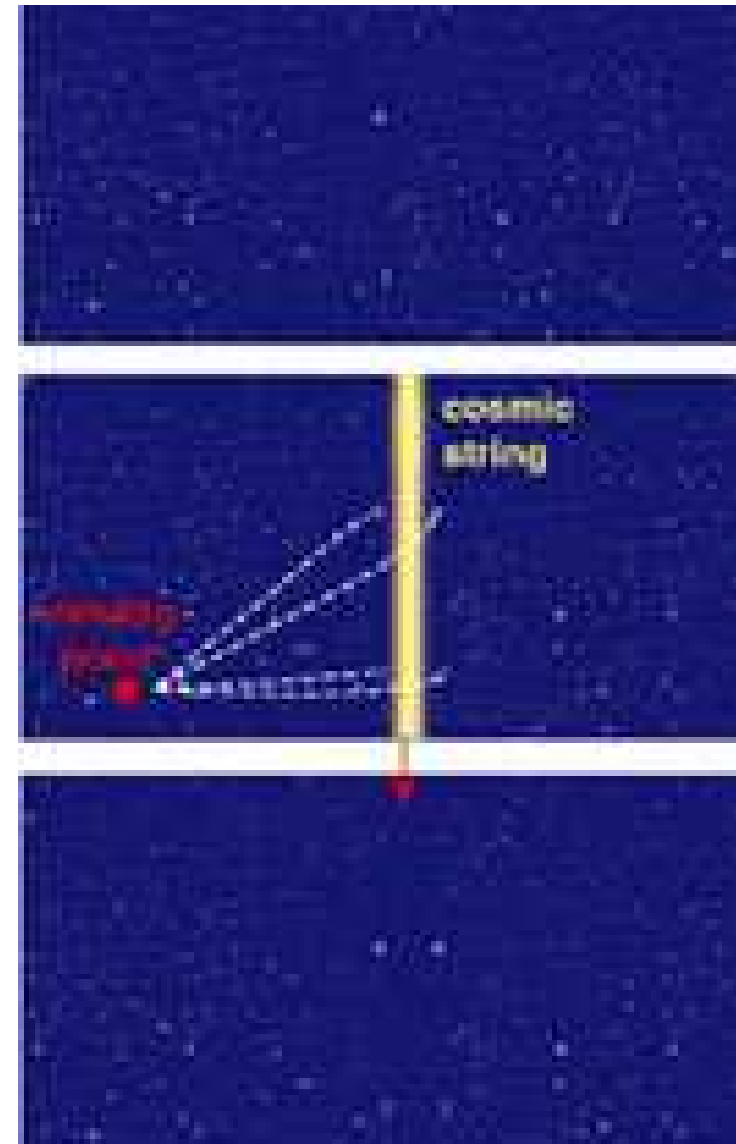
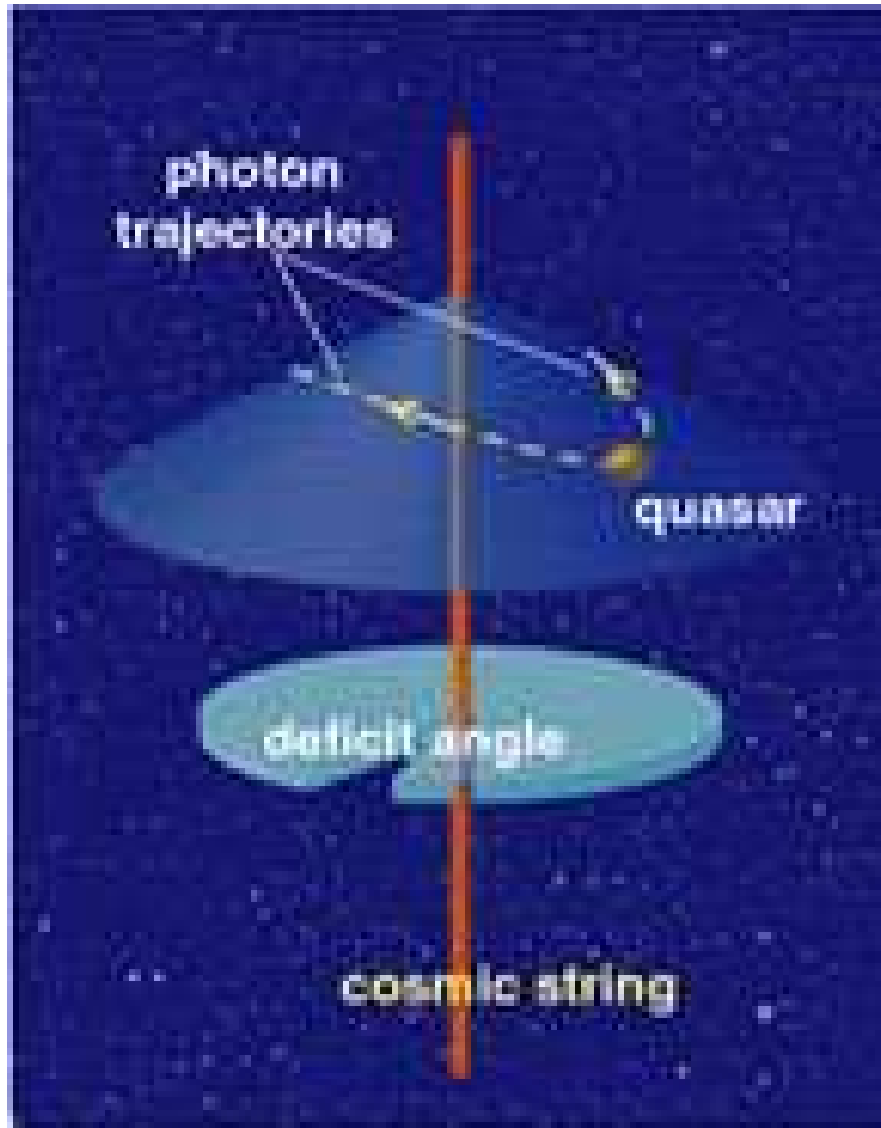


# Cosmic String Search Result

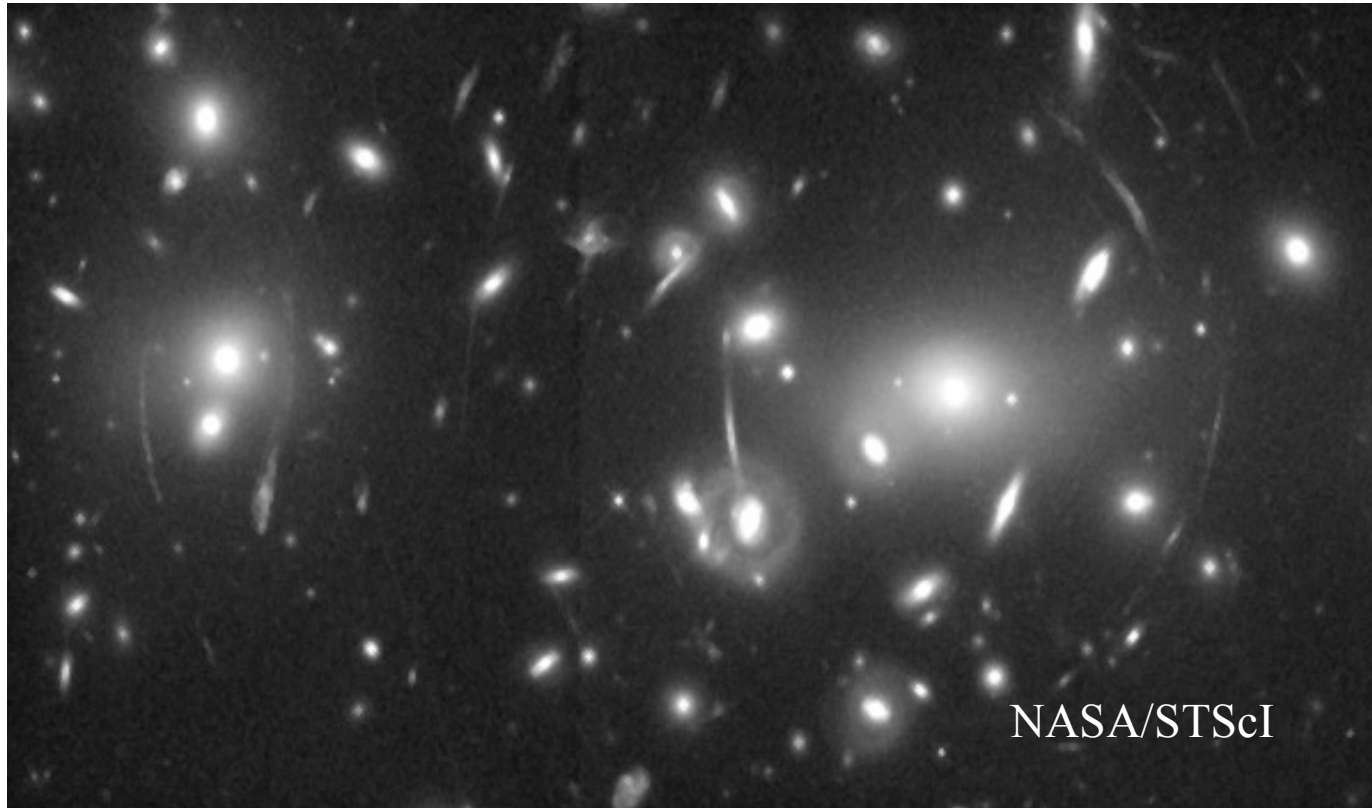




# Gravitational Lens by Cosmic Strings



# Gravitational lenses



NASA/STScI