

# The Urania Portal

## – a Copenhagen Virtual Observatory Initiative

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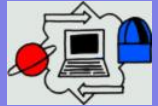
[Close](#)

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# 1. Virtual Observatories (VO)

## Perspectives on modern astrophysics

- Progress in Astronomical research is markedly Technology driven.
- “Luxury problem”: How to prevent the ensuing *Information Overload*, and exploit the possibilities instead.
  - Surveys (e.g.):
    - \* Digitized Sky Survey (DSS-2) :  $\sim 3$  TB
    - \* Sloan Digital Sky Survey (SDSS) :  $\sim 40$  TB
    - \* GAIA :  $\sim 200$  TB
  - Archives (e.g.):
    - \* ESO :  $\sim 20$  TB yr<sup>-1</sup>
    - \* ESO archive, with VST online :  $\sim 50$  TB yr<sup>-1</sup>
  - AO storage capacity:  
HDD  $\sim 1.5$  TB, DVD jukebox  $\sim 3 - 12$  TB.



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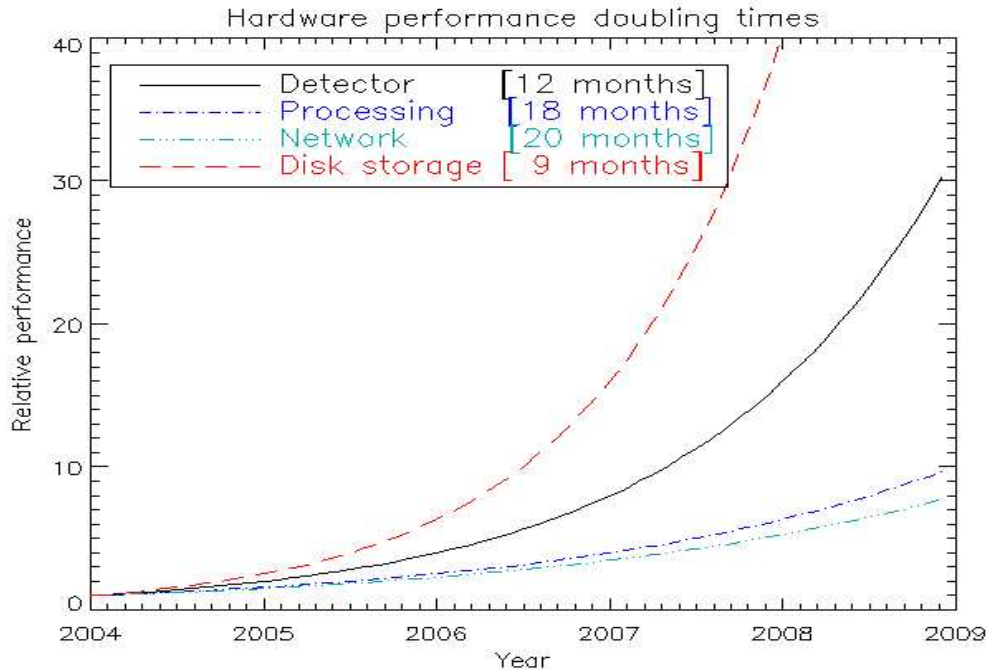
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# VO – Technology Driven and Technology Limited

- The projected increases in hardware performance requires new approaches, e.g.:
  - Distributed computing (e.g. GRID).
  - Efficient on-site analysis and pipelining.



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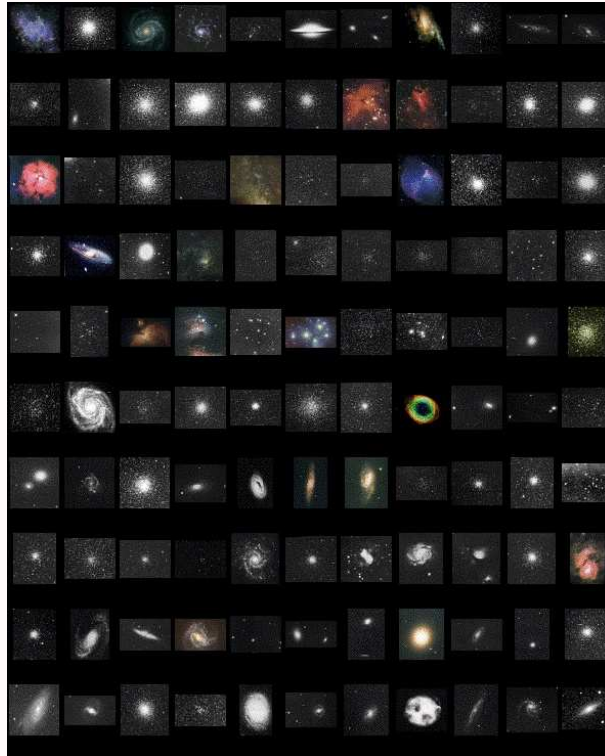
Quit

# VO – Perspectives on Modern Astrophysics

## A transition of scale:

How to go from the rôle of “traditional” astrophysics of analysing a few, to a hundred, objects at a time

– to the challenge of operating with millions to hundred of millions of objects?



The 110 Messier objects (SDSS)



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## Virtual Observatories – Concept:

- More efficient use of future and existing data archives and surveys.
- Enable:
  - Rapid, cross-frequency searches.
  - Multi-variate clustering correlations.
  - Data mining for e.g. transient events.
  - Testing-ground of simulations against “real data”.
- Considerations:
  - Inter-operability, standards (e.g. Astro-XML).
  - Data calibration.
  - Data quality.
- Projects: **AVO** + **NVO**  $\Rightarrow$  **IVOA**
- Required: Highly trained developers/users (**Urania Portal**).



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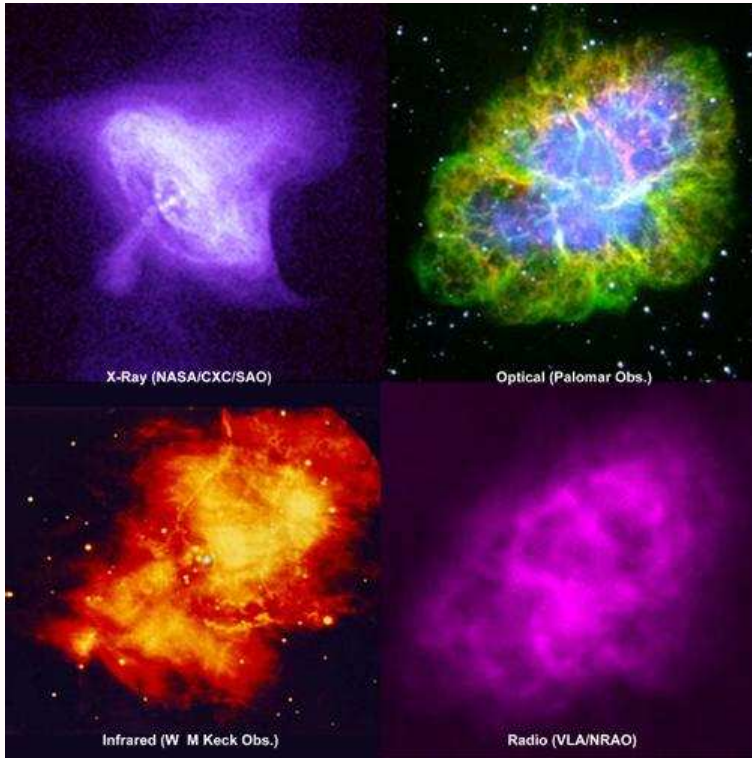
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# Virtual Observatories (VO)

## VO Concept

Cross-frequency searches.



Crab nebula in X rays, optical, infrared and radio



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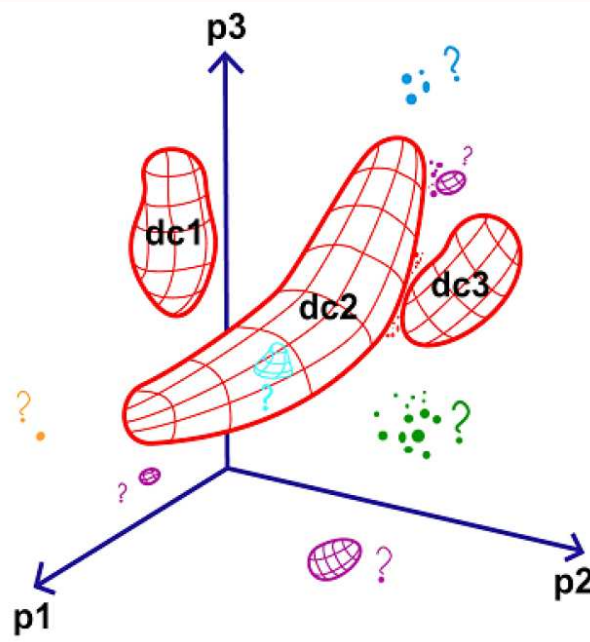
[Quit](#)

# Virtual Observatories (VO)

## VO Concept

### Multi-variate clustering correlations.

- Determine new (or refine existing) empirical relationships similar to e.g. the *Colour-Magnitude Relation* for stars or the *Fundamental Plane Relation* for elliptical galaxies.
- Discover and classify rare objects, e.g. brown dwarfs or high-redshift QSOs.



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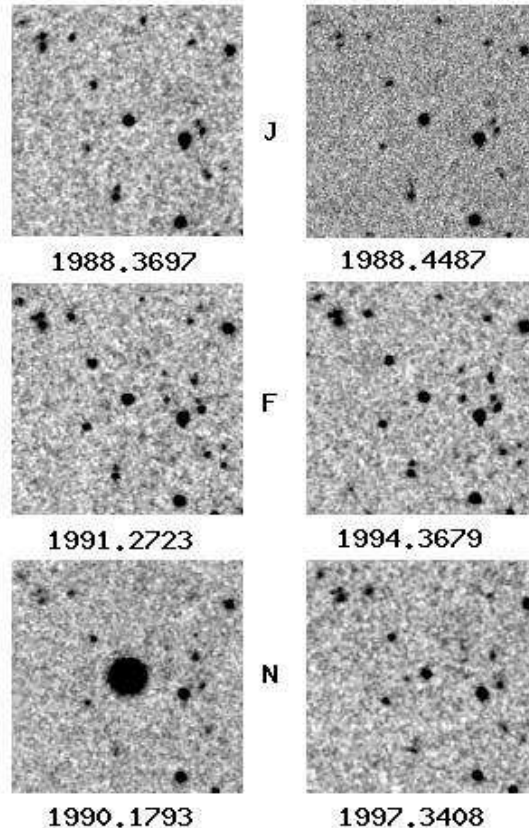
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Data-mining for e.g. transient or unusual events.

- Classify variable objects such as stars and (lensed) QSOs.
- Discover and analyse transient events, e.g. SNe, GRBs, asteroids.
- Discover new object classes, e.g. *L and T dwarfs*.



Star with peculiar variability discovered from several epochs of survey data.



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## 2. Urania – Rationale

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Main ambition of the Urania Astronomical Virtual Observatory initiative:

- To develop a local prototype AVO portal,
- ... in order to augment the quality of the astronomical education,
- ... by enabling students to have ready access and opportunity to work with “real” science-grade data within standard course time-frames,
- ... and thereby, through the “hands-on” approach, facilitate broader understanding of the tools and possibilities of modern astrophysics.



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## Urania – Rationale – 2

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In addition, it is purposed:

- to develop and introduce a set of tools applicable, not only to tests and exercises,
- ... but also to research-based projects, instigated by student and professional researcher alike.

Several of the tools included in the Urania AVO have already proven to be of great practical, recurrent use for a large number of researchers.



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# 3. Urania – Implementation

## Interface software:

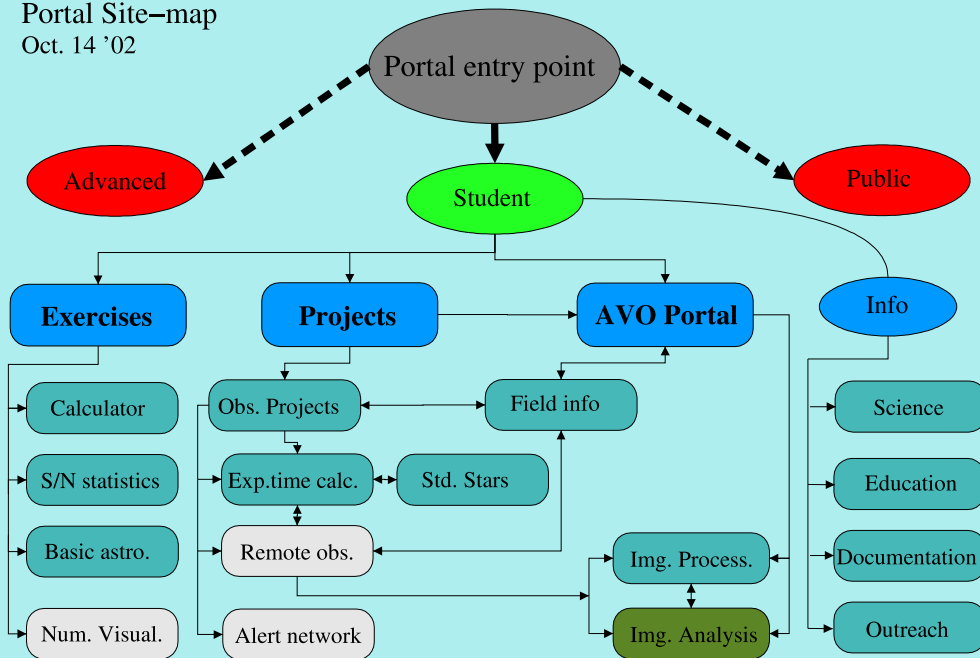
Standard HTML-compliant internet browser.

## Module implementation:

HTML (php, javascript) front-end for e.g. perl, IDL.



Portal Site-map  
Oct. 14 '02



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# 4. Urania – Portal

URL : <http://www.astro.ku.dk/avo>

- **Tools of the Trade**, e.g.:
  - Easy Archive-access.
  - Smooth Data-reduction.
- Interactive **Exercises** and Online **Projects**.



**NIELS BOHR INSTITUTTET**  
for ASTRONOMI, FYSIK og GEOFYSIK  
KØBENHAVNS UNIVERSITET

## Urania Astrophysical Virtual Observatory

Det Astrofysiske Virtuelle Observatorium (AVO) på Niels Bohr Institutet for Astronomi, Fysik og Geofysik.

**Startside**  
**Øvelser**  
**Projekter**  
**Sugning**  
**Info**

Her finder du astrofysiske redskaber, både til brug i dine egne projekter, såvel som i kurser på astronomistudiet ved Københavns Universitet.

AVO portalen er på nuværende tidspunkt primært rettet mod astronomi-studerende på første del (bachelor-studiet), men andre interesserede er velkomne til at anvende vores redskaber, der kan bruges til generelle beregningsopgaver, observationsplanlægning, billedanalyse mm.

**Site-indhold:**

**Øvelser og Projekter**  
[Interaktive øvelser og Forslag til øvelser](#),  
[Kursusøvelser](#), [Projekter](#).

**Redskaber**  
[Kosmologisk lommetænger](#), [Objektspøgning](#), [Felt information](#), [Billed-reduktion](#),  
[Eksponerings-tids-estimator](#).

**Information**  
[Astronomi-afgø](#), [Kurser](#), [SiteMap](#),  
[Sitedokumentation](#)

Himlen netop [Solen i dag](#)  
ng

**Urania...**  
Urania er i romersk mytologi astronomiens muse, men navnet peger også tilbage på astronomiens historie, under mere lokale himmelstrøg: Tyge (senere Tycho) Brahe, der byggede observatoriet Stjerneborg på øen Veen, opkaldte sit slot efter Urania (Uraniborg).

*For den der holder af at lade sjælen flyve mellem himlens tinder, og med sit itelekt at nærme sig til stjernerne, hans stræben ligner ikke menneskers, men guders, han ejer noget der kan hæve sjælen op fra jorden.*

Tycho Brahe, 1573: *Elegi til Urania*.

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## 4.1. Urania – Tools

At present, the following tools are available for use at the **Urania** portal:

- Object Query.
- Field Information Generator.
- Archive Interface.
- Exposure Time Estimator.
- Cosmological Calculator.
- Online Image Reduction.



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# Urania – Object Query

## Tools



The **Object Query** interface acts as a front-end for various specific-object info-generating routines (such as the **Field Information** system for objects outside the Solar System).

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Projekter  
**Søgning**   
Felt-information  
Eksponeringstid  
Info

  
The AVO group  
April 1, 2004

Dato og tid: 01-04-2004, 22:52:31 *dansk tid* / 01-04-2004, 20:52:31 *GMT/CUT*

## Søgning

Objektsøgning:    [Hjælp!](#)

<a href="#">Observationsforberedelse</a> <i><a href="#">Felt-info</a>, <a href="#">eksponeringstid</a></i>	<a href="#">Beregning</a> <i><a href="#">Kosmologi</a>, <a href="#">Planck</a>, <a href="#">fotoner</a></i>
<a href="#">Projekter</a> <i><a href="#">Arkiv</a>, <a href="#">observation</a></i>	<a href="#">Øvelser</a> <i><a href="#">Kursusøvelser</a>, <a href="#">interaktive</a></i>
<a href="#">Stjerner</a> <i><a href="#">Standardsjerner</a>, <a href="#">spektralklasser</a>, <a href="#">spektre</a></i>	<a href="#">Information</a> <i><a href="#">Fagligt</a>, <a href="#">dokumentation</a>, <a href="#">outreach</a></i>
<a href="#">Kurser (eksterne links)</a> <i><a href="#">A12</a>, <a href="#">A223</a>, <a href="#">Studieinformationer</a></i>	<a href="#">Diverse</a> <i><a href="#">NIK</a>, <a href="#">himlen netop nu</a>, <a href="#">solen i dag</a></i>

The AVO group Last modified: November 05 2002 12:06:52.

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## Urania – Object Query – 2

## Tools



The **Object Query** interface parses:

- Type-specific object searches:
  - Minor Planet.
  - Planet.
  - Extragalactic.
- Query allowed by object name or designation, e.g. :
  - Minor planets: “1976 JF2”, “2476” or “Andersen”.
  - Planets and Moons: “Moon” or “Månen”.
  - Extragalactic: “NGC5194”, “Arp 085” or “M51”.

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# Urania – Field info module

# Tools

The **Field Information module** provides:

- Field selection by coordinates (in all the favourite formats), or by object search through the **Object Query Interface**.
- Finding chart (DSS-II) of chosen field.
- Specific field-info, e.g. Galactic extinction, Moon distance.



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### Resultat for M51

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Projekter  
Søgning   
Felt-information  
Eksponeringsstid  
Info

Koordinater				
Koordinater	lt mm ss.s (J2000)	lt mm ss.s (B1950)	grader (J2000)	grader (B1950)
RA	13 29 52.4	13 27 46.0	202.468	201.942
Dekl.	+47 11 41	+47 27 09	+47.195	+47.452
Billed-radius				20.0'
Galaktiske (l,b)				(104.85, 68.56)

**Felt-information**

Felt-ekstinktion: For 2003-04-23 : Wed Apr 23 14:00:08 MEST 2003 :

Av:	0.18	Månen oplyst:	0.5
Ar:	0.15	Månens afstand fra feltet	117 "
Av:	0.11		
Ar:	0.09	Solens afstand fra feltet:	120 "
Ar:	0.06		

The AVO group  
April 1, 2004

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### Resultat for M51

Startside  
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Søgning   
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Eksponeringsstid  
Info

**Søgekort**

Klik for et billede med bedre opløsning

Digitized Sky Survey, [ESO online DSS](#), centreret omkring:  
RA = 202.468, Dekl. = +47.195 (J2000)  
Alternative DSS-sites findes på [CADC](#) og [STScI](#).  
[Eksponeering- og kataloginformation](#) ang. DSS-plates fra DSS-faq.  
[Kataloginformation](#) fra DSS-skanningen.  
[Fotometrisk kalibrering](#) af Digitized Sky Survey-billeder.  
Specifikt DSS-plate [header-information](#).  
Komplet [FITS-header](#) af feltet.  
DSS-2 [red](#) 20.0x20.0 buemin. billede af feltet.  
DSS FITS-billede kan downloades [her](#) (2784 kb).

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April 1, 2004

# Urania – Field info module – 2

## Tools




- Visibility plots for selected observatories, e.g. NOT, La Silla, Paranal, Brorfelde.
- Direct query-access to relevant archives:
  - Surveys (e.g. DSS-II, 2MASS).
  - Data-archives (e.g. ESO, HST).
  - Astrometry (e.g. USNOA2.0, GSC2).
  - Object-databases (e.g. SIMBAD, NED).

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### Resultat for M51

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Ovølsler  
Projekter  
Søgning   
Felt-information  
Eksposeringstid  
Info

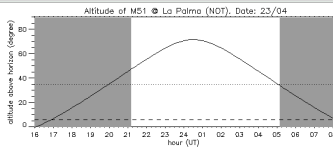
Radius	Forekomst	Bemærkninger
<b>Kataloger (surveys):</b>		
DSS	10	DSS1, Red, Blå, Infra-rod Digital Sky Survey
2MASS	10	J. H. K. Alle 2 Micron All Sky Survey
IRAS	10	12 micron IRAS
SDSS	10	Objekt.katalog Sloan Digital Sky Survey
<b>Data-arkiver:</b>		
ESO	10	VLT VLT
MAST	10	Data.katalog Multimesion Archive at STScI
CFHT	10	Data.katalog Canadian-French Hawaiian Telescope
JCMT	10	Data.katalog James Clerk Maxwell Telescope
<b>Astrometry &amp; Photometry:</b>		
USNO-A2	10	Sjeme.katalog U.S. Naval Observatory Catalogue
USNO-A1.0	10	Sjeme.katalog U.S. Naval Observatory Catalogue
GSC1	10	GSC1 Guide Sjeme-katalog (ver. 1.2)
GSC2	10	GSC2 Guide Sjeme-katalog (ver. 2.2)
<b>Objekt-databaser:</b>		
SIMBAD	10	Objekt.katalog Set of identifications, measurements and bibliography for Astronomical Data
NED	10	Objekt.katalog NASA Extragalactic Database
LEDA	10	Galakseliste, Kort Lyon-Meudon Extragalactic Database



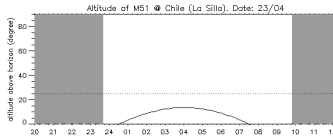
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### Resultat for M51


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Søgning   
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Eksposeringstid  
Info



Altitude of M51 @ La Polino (NOT), Date: 23/04



Altitude of M51 @ Chile (La Silla), Date: 23/04



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# Urania – Exposure Time Estimator

## Tools

### Exposure Time Estimator,

Estimates exposure time needed to obtain the required signal-to-noise ratio for a given object.

Uses preset or custom telescope+detector configurations.

For use in planning observational projects.



**Beregning af eksponeringstid**

*Input-data*

Vælg teleskop og instrument:

Flux-fordeling:

Observationsforhold:

Output format:  S/N-forholdforhold   Eksponeringstid  sekunder

[Avanceret version](#)

The AVO group April 2004

**Estimeret resultat af eksponering**

Teleskopets aperture: 1.54 m  
CCD-detektors pixelstørrelse: 0.39  $\mu$ pixel  
CCD-detektors subscanning: 3.3  $e$ /pixel  
CCD-detektors markertæthed: 2  $e$ /pixel  
CCD-detektors symfide: 13.7  $^\circ$

dk15m-dfosc:

**Eksponeringstid**

S/N-forhold

Eksponeringstid (s)

Eksponeringstid (s)	S/N-forhold
0	0
2	~4.5
4	~7.5
6	~9.5
8	~11.5
10	~13.5
12	~15.5

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The example is for a  $V = 19$  mag. object, observed with the DK-1.5m+DFOSC for a  $S/N \approx 10$ .

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# Urania – Cosmological Calculator

## Tools

### Cosmological Calculator,

- For use in solving exercises.
- For use in planning (observational) projects.
- Uses preset or custom sets of cosmological parameters.



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#### Kosmologisk lommeregner

Indtast de kosmologiske parametre, enten for dit favorit Univers, eller for et teoretisk verdensbillede! Resultatet gives i form af karakteristiske parametre ved den angivne rødforskydning  $z$ .

#### Indtast kosmologiske parametre

Kosmologi	$\Omega_m$	$\Omega_\Lambda$	$H_0$	Rødforskydning ( $z$ )	Vælg!
A-univers (fladt)	0.3	0.7	65	0.42	☑
Univers m. lav tæthed (åbent)	0.3	0.0	65	0.1	☐
Einstein-de Sitter univers (fladt)	1.0	0.0	65	0.1	☐
Favorit-univers	0.3	0.7	65	0.1	☐

Information: [Kosmologi](#)

OK | Forfra

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Inputværdier			
$H_0$	$\Omega_m$	$\Omega_\Lambda$	$z$
65 km s <sup>-1</sup> Mpc <sup>-1</sup>	0.3	0.7	0.0
			0.42
Resultat for $\Lambda$ -kosmologi og $z = 0.42$			
Afstand (baseret på luminositet):	2478.17 Mpc		≈ 7.646e+27 cm
Afstand (baseret på vinkeldiameter):	1229.01 Mpc		≈ 5.96 kpc/arcsec
Afstand (fra tilsvarende simpel Hubble-flow):	1937.10 Mpc		≈ 5.977e+27 cm
Afstand (langs comoving sigtelinje):	1745.19 Mpc		≈ 5.384e+27 cm
Afstand (vinkelret på comoving sigtelinje):	1745.19 Mpc		≈ 5.384e+27 cm
Universets nuværende alder ( $z=0$ ):	14.501 Gyr		
Universets alder ved $z=0.42$ :	9.719 Gyr		≈ 67.0 % af nuværende alder
Lookback-tid til $z=0.42$ :	4.783 Gyr		≈ 33.0 % af nuværende alder
Kritisk tæthed ved $z=0$ :	7.939e-30 g/cm <sup>3</sup>		
Kritisk tæthed ved $z=0.42$ :	2.273e-29 g/cm <sup>3</sup>		
Decelerationsparameter:	-0.55		
Afstandsnødt:	42.0		

Information: [Kosmologi](#)



## Online Image Reduction – archive browser,

- For direct use in observational projects, either based on archive-data, and/or on own observations.
- Interactive, “Smart” browsing of image-archives.

### Billed-reduktion:

For at kunne foretage en eksakt, kvantitativ analyse af videnskabelige astronomiske billeder, er det nødvendigt først at reducere dem. Astronomisk billed-reduktion indebærer bl.a. at kalibrere billed-data mod forskellige instrument-specifikke effekter. I dette modul bliver videnskabelige data (i FITS-format) reduceret ved at behandle dem med reduktionsdata der bl.a. beskriver pixel-til-pixel variationen henover CCD-chippen samt dens udlæse-niveau (såkaldte *flat-felt* billeder). Derefter kan de reducerede billeder WCS-kalibreres (World Coordinate System) og kombineres.

Se [Data-reduktion](#) samt [CCD](#) for yderligere information vedr. billed-reduktion.

### Data oplysninger

Angiv placering for **videnskabelige** billeder:

Arkiv:  Fil mønster:

Angiv placering for **flat-felt** billeder:

Arkiv:  Fil mønster:

Filter .fits-filer (scan files for FITS-like headers)

### Frame-URLs:

url\_sci = <http://www.astro.ku.dk/avo/reduction/archive/000926/0927/not/sci>  
url\_flat = <http://www.astro.ku.dk/avo/reduction/archive/000926/0927/not/flat>

### Billeder benyttet til reduktion:

sci\_files = j1270035.fits j1270036.fits j1270037.fits  
flat\_files = j1270025.fits j1270025.fits j1270087.fits

### Reducerede Billeder:

Videnskabelige data	billed-fil	Teleskop (Instrument)	Objekt	(RA,Dec) (Equinox)	Filter	Eksposerings-tid (s)	Observations dato	.fits Header	gif-previews
<input checked="" type="checkbox"/>	j1270035.fits	NOT (ALFOSC-FASU)	-	G236.06359892000, 51.77652648911 (2000.0)	6R476	300.000	2000.09.27	header	
<input checked="" type="checkbox"/>	j1270036.fits	NOT (ALFOSC-FASU)	-	G236.0633477751, 51.77679012571 (2000.0)	6R476	300.000	2000.09.27	header	
<input checked="" type="checkbox"/>	j1270037.fits	NOT (ALFOSC-FASU)	-	G236.06363451401, 51.7781327173 (2000.0)	6R476	300.000	2000.09.27	header	

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## Online Image Reduction – WCS-calibration,

- Reduction of science images with selected flat-field images (if selected).
- Science images are calibrated to the World Coordinate System (WCS).
- WCS-calibrated images are median-combined into one ready-to-use image.

Frame-URLs:  
url\_sci = <http://www.astro.ku.dk/avofredaction/archive/0009>

Data benyttet til WCS-kalibrering:  
wcs\_files = j1270035w.fits j1270036w.fits j1270037w.fits

Marker alle | Afmarker alle

**WCS-kalibrerede Billeder:**

Videnskabelige data	billed-fil	Teleskop (Instrument)	Objekt	(RA, Dec) (Equinox)	Filter	Eksponeringsstid (s)	Observations dato	.fits Header	gif-previews	Billed
<input checked="" type="checkbox"/>	j1270035w.fits	NOT (ALFOSC-FASU)	-	(17:04-18.436, +51:46:06.49) (2000)	6R#76	300.000	2000-09-27	header		<a href="#">gif</a> <a href="#">fits</a>
<input checked="" type="checkbox"/>	j1270036w.fits	NOT (ALFOSC-FASU)	-	(17:04-18.455, +51:46:08.10) (2000)	6R#76	300.000	2000-09-27	header		<a href="#">gif</a> <a href="#">fits</a>
<input checked="" type="checkbox"/>	j1270037w.fits	NOT (ALFOSC-FASU)	-	(17:04-18.515, +51:46:12.10) (2000)	6R#76	300.000	2000-09-27	header		<a href="#">gif</a> <a href="#">fits</a>

Combine selected images | clear

## 4.2. Urania – Exercises

The goal of the **Urania Portal Interactive Exercises**:

- Online solvable, self-contained exercises (i.e. full documentation enclosed) – for direct use in online education (“*fjern-undervisning*”).
- To provide a didactic approach to physical and astronomical phenomena and concepts (e.g. central theorems and formulae) through iterative interaction and visualisation.
- Automatic evaluation

Sample Interactive Exercises:

- **M55** and spectra – concerning stellar-classification.
- SN2003X – Examine a virtual Supernova.



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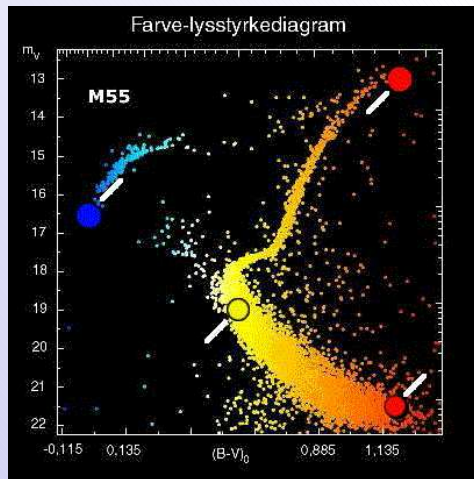
[Close](#)

[Quit](#)



## The M55 Globular Star-cluster:

- Click on one of the stars to see the stellar spectrum.
- Determine the stellar spectral type and class from comparison with template spectra, and then estimate the distance to the cluster.



M55 er en stor stjernebald, der ligger i stjernerimningen mod Skytten. H-R diagrammet (til højre) illustrerer, at M55 indeholder mange forskellige typer af stjerner. [Mere info.](#)

**Øvelse: M55 og spektre**

Tilføjke, du fandt en afstand, der var mindre end 15% fra den "korrekte" værdi! Diagrammet til højre er nu udskiftet med et Hertzsprung-Russel-diagram, der viser de absolute størrelsesklasser, for alle stjernerne i M55. Flere spektre passer sammen, ejerne indbefindes usikkerheden på afstanden, hvad kan man lære af det?

[Beris-kode?](#)  
[Ny stjerne?](#)

Den valgte stjerne har:  
Tilsvarende størrelsesklasse  $m_V = 13.1^{mag}$   
Farveindeks  $B-V = 1.1725^{mag}$   
Spektrum til højre.

Type: K 4 III

$13.1^{mag} + 1^{mag} = 5 \log d - 5 + 0.44$   
Afstanden er  $d = 5395.1$  pc. (fej! < 15%). [Bravoo!](#)

Standardispektrum (ggrn) og M55-stjerne (svrt).

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## 4.3. Urania – Projects

### Online Project Descriptions:

- Detailed suggestions for astronomical experimental/observational Projects.
- Either for direct implementation or for further inspiration.
- Outlined for the application of relevant **Urania-tools**.
- Designed for “real” science, i.e. to facilitate the use of actual scientific data, from e.g. research archives such as the ESO image data-base.



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## Urania – Projects – Examples

## Projects

Sample Project Descriptions:

- Determination of **Asteroid** ephemerides.
- VLT/HST archive-data – perform new, independent analyses on existing, science-grade data – or confirm (or reject) previous findings.
- X-ray astronomy – study interesting X-ray emitting objects and clusters through archive-data.
- Cross-frequency study – compare source properties in different wavelengths through judicious archive-use.
- Design your own observing project for Danish telescope facilities, such as the DK-1.5m, the Brorfelde-0.5m or the NeST-0.25m.



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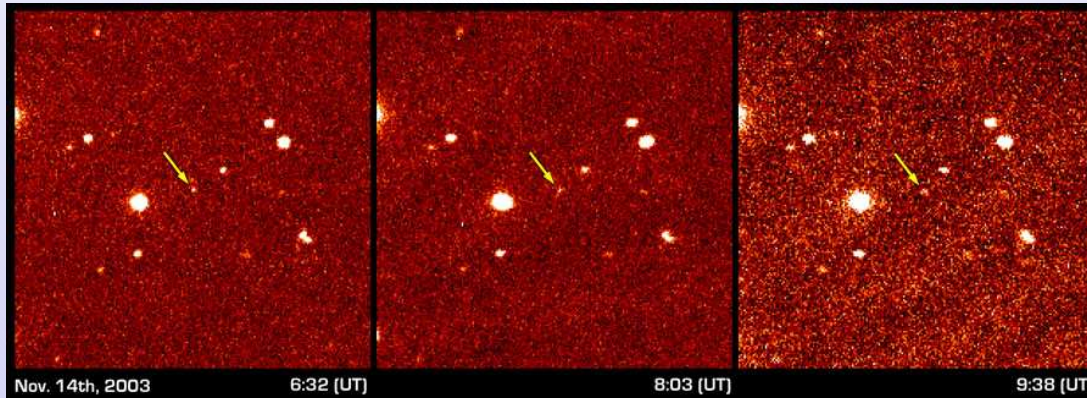
[Quit](#)

## Urania – Projects – Asteroids

## Projects

Determination of Asteroid epherimedes:

- Perform follow-up observations (on e.g. LINEAR detections).
- Detailed info/tools to determine ephemerides from position.
- Can likely result in **MPEC**-publication(s).



Three epochs of **2003 VB12** "*Sedna*" at  $R \sim 20.5$ .



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## 5. Urania – Future Work

### Urania portal – Outlook and Future work,

- Upgrade of the Cosmological Calculator:
  - More efficient (faster) core code
  - Implement “new” cosmology (e.g. *Quintessence*).
  - Calculate  $k$ -correction for template objects.
  - Addition of visualisation features.
- Improve on online analysis with e.g. a photometry add-on module to the **Image Reduction** service.
- Remote observing
  - Brorfelde, DK-1.5m, NOT.
- Inclusion of contributed exercises and project modules.
- International version.



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## Production Notes

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This presentation is prepared using the **pdfscreen-**package for  $\text{\LaTeX}$ .

pdfscreen: <http://www.river-valley.com>.

Written exclusively in the **Vim**-editor.

vim: <http://www.vim.org>.

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