Observational Astrophysics

Credit: Rafael Barrena Delgado

Manu Linares – NTNU – Physics

Special thanks to:

Thomas Augusteijn, Akke Viitanen,

Sergio Armas-Perez, Amanda Djupvik

NTNU
Norwegian University of Science and Technology

UPC
UNIVERSITAT POLITÈCNICA DE CATALUNYA
BARCELONATECH

OBSERVATIONAL ASTROPHYSICS

MSc Physics – NTNU - Spring 2022

- **MOTIVATION: "LOOK AT THE SKY TO LEARN PHYSICS"**

"Look" implies scientific methods, instruments and techniques that must be learned/used/applied thoroughly.
"Sky" means planets, stars, nebulae, dust/gas clouds, clusters, galaxies, clusters of galaxies... and the universe.
"Learn" by comparing theories with observations (can't make experiments: "someone else runs the lab").
"Physics" means gravitation, nuclear and particle physics, electromagnetism, mechanics, thermodynamics...

- **THIS COURSE: HOW TO "LOOK"**

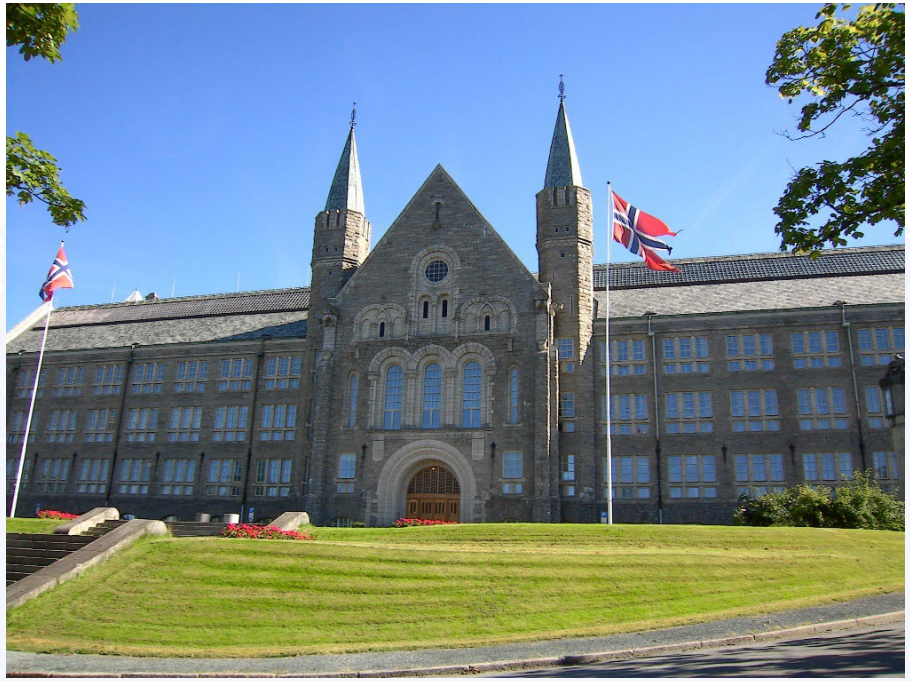
FY 3490 (FY 3215 from spring 2023) Observational Astrophysics: Manuel Linares

- **CONTEXT: "SKY" covered by these courses at NTNU-IfY**

FY 2450 Astrophysics 1: Jens Andersen – Foteini Oikonomou (from spring 2022)
FY 3451 Astrophysics 2: Michael Kachelriess (from fall 2021)
FY 3452 Gravitation and Cosmology: Michael Kachelriess

- **PILOT COURSE: 2022 January-June**

- **TARGET: 1st year MSc (& 3d year BSc) Physics**



OBSERVATIONAL ASTROPHYSICS

MSc Physics – NTNU - Spring 2022

COURSE CONTENTS:

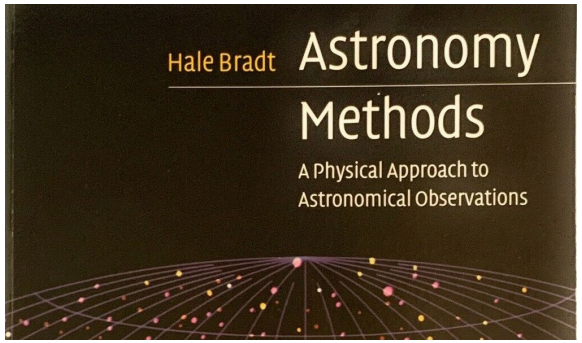
1. Introduction: observing the Universe from Earth
2. Telescopes: collecting (and focusing) light
3. Detectors: recording (and measuring) light
4. Multi-messenger Astronomy: *Michael Unger & Michael Kachelriess*
   Goals/Skills: ***FUNDAMENTALS OBSERVATIONAL ASTROPHYSICS****.*

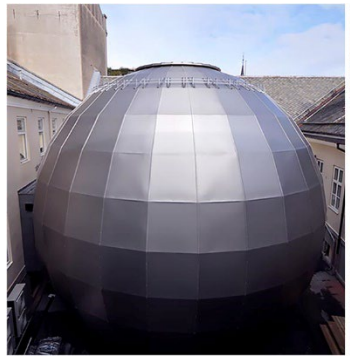
5. Astronomical Techniques (3 AstroLAB sessions,1-1.5 week each; Mar-Apr)
   Goals/Skills: ***DATA ANALYSIS. LINUX****.*
   Deliver: 1 report per session (individually in 2022)

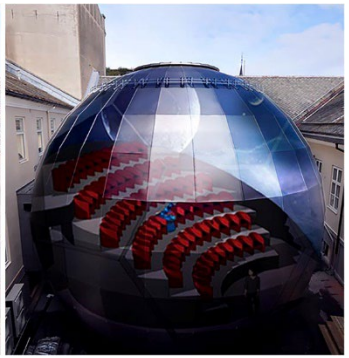
6. Observing Project: Nordic Optical Telescope (Remote observations at the NOT, Apr-May)
   Goals/Skills: ***RESEARCH PROJECT. TEAM WORK. WRITING.***
   Deliver: 1 proposal + 1 essay/article per group (2-3 students/group)

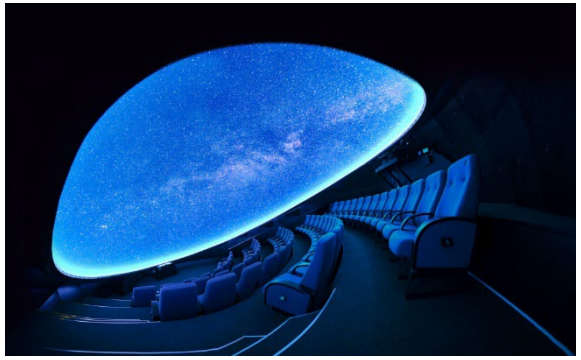
OBSERVATIONAL ASTROPHYSICS

MSc Physics – NTNU - Spring 2022









Lectures (Classroom)

- Fluxes, magnitudes, BB radiation, redshifts
- Telescopes, space- and ground-based, radio-gamma-ray
- Detectors, statistics
- Cosmic rays, neutrinos, gravitational waves

Lecture 1.2 (Planetarium Vitensenteret Trondheim)

- The celestial sphere
- Movements: Moon, Sun, Planets. Trigonometric parallax
- Coordinate systems in Astronomy, Spherical Trigonometry
- Visibility
- Time systems in Astronomy

AstroLABs & Observing Project (Linux Lab, FNS)

- P5.1: Optical photometry
- P5.2: Optical spectroscopy
- P5.3: X-ray timing
- Observing proposal
- Project report

NORDIC OPTICAL TELESCOPE Proposal 65-
APPLICATION FOR OBSERVING TIME
OBSERVING PERIOD 65 (Observational Astrophysics 2022-Spring)
April 1, 2022 - October 1, 2022

1. Title of proposal:

2. Abstract:

3. Principal Investigator: (**NB:** The P.I. will supervise the contents of this proposal.)

Name: Manuel Linares
Institute: NTNU, NO
Postal address: Høgskoleringen 5, 7491 Trondheim, Norway
Telephone: +47 73592206
Fax:
E-mail: manuel.linares@ntnu.no

4. Co-investigators and e-mails: (**NB:** The co-Is have full responsibility for the content of this proposal!)

Student1 Lastname1 email1@stud.ntnu.no
Student2 Lastname2 email2@stud.ntnu.no
Student3 Lastname3 email3@stud.ntnu.no

6. Observing mode(s) requested and preferred scheduling (MAX: 4 Runs):

NB: An "Observing run" is a single, contiguous block of time with a single instrument and mode. Only ALFOSC imaging and long-slit spectroscopy modes are allowed. The total time allocated per group ("X", given in hours in box 9. below) can be split among these two modes, if this is justified by the scientific goals. A clear observing night at the ORM in the second half of April has about 8 useful hours, twilight-to-twlight. You probably have a DATE/HALF already allocated to your group (keep that and visibility in mind when selecting targets). Note that during one run you can observe multiple targets (with the same intrumental configuration).

Run	Mode	Instrument	Time	Date/Half	Moon	Seeing	Sky
A	R	ALFOSC-imaging	X/2 H	April 20/1st half	N	N	T
B	R	ALFOSC-longslit	X/2 H	April 20/1st half	N	N	T

7. Number of nights already awarded to project: 3
8. Number of groups in current semester: 5+1
9. Number of hours allocated per group: 4

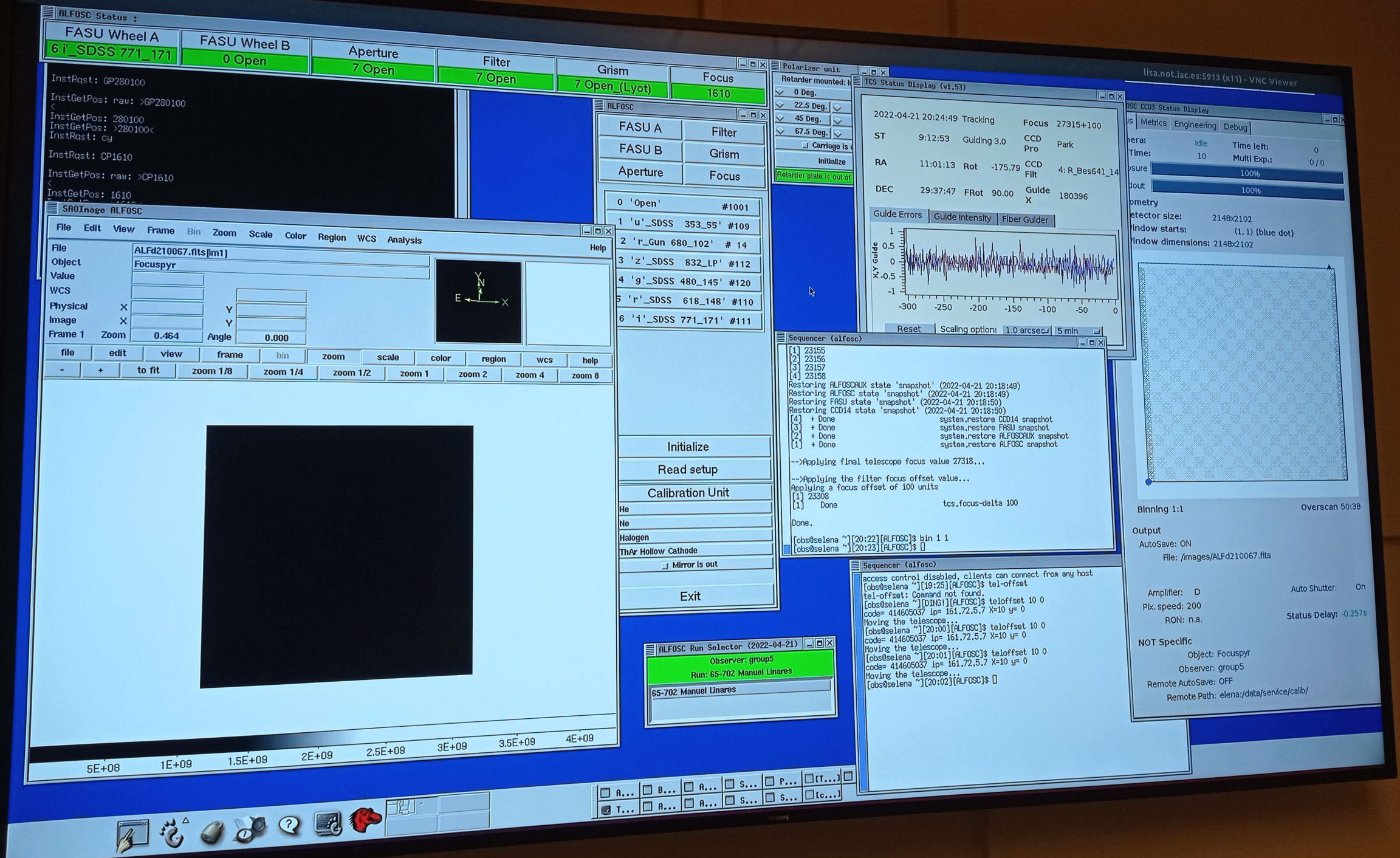
10. Any other special constraints on the scheduling?

OBSERVING PROJECT: NORDIC OPTICAL TELESCOPE

- ALFOSC imaging/long-slit spectroscopy
- Choose target (WD, AGN, NS; February-March)
- Plan & propose (March-April)
- Observe (remotely; April 20-22)
- Analyze & report (May)

Credit: Arthur Radko


FASU Wheel A
FASU Wheel B
Aperture
Filter
Grism
Focus
0 Open
7 Open
7 Open
7 Open_(Lyot)
1610
FASU A
FASU B
Initialize
Read setup
Calibration Unit
Exit
DATASALEN ER IKKE EN KANTINE
Spising og drikking på datasalen er forbudt.
Overtredelser medfører bortvisning og tap av tilgang.
ED-tjenesten


ALFOSC Status :
FASU Wheel A
6 i_SDSS 771_171
FASU Wheel B
0 Open
Aperture
7 Open
Filter
7 Open
Grism
7 Open_(Lyot)
Focus
1610
InstRqst: GP280100
InstGetPos: raw: >GP280100
InstGetPos: 280100
InstGetPos: >280100<
InstRqst: cy
InstRqst: CP1610
InstGetPos: raw: >CP1610
InstGetPos: 1610
SAOImage ALFOSC
File Edit View Frame Bin Zoom Scale Color Region WCS Analysis Help
File ALFd210067.fits[im1]
Object Focuspyr
Value
WCS
Physical
Image
Frame 1 Zoom 0.464 Angle 0.000
file edit view frame bin zoom scale color region wcs help
- + to fit zoom 1/8 zoom 1/4 zoom 1/2 zoom 1 zoom 2 zoom 4 zoom 8
5E+08 1E+09 1.5E+09 2E+09 2.5E+09 3E+09 3.5E+09 4E+09
ALFOSC
FASU A
Filter
FASU B
Grism
Aperture
Focus
0 'Open' #1001
1 'u'_SDSS 353_55' #109
2 'r_Gun 680_102' # 14
3 'z'_SDSS 832_LP' #112
4 'g'_SDSS 480_145' #120
5 'r'_SDSS 618_148' #110
6 'i'_SDSS 771_171' #111
Initialize
Read setup
Calibration Unit
He
Ne
Halogen
ThAr Hollow Cathode
Mirror is out
Exit
Polarizer unit
Retarder mounted:
0 Deg.
22.5 Deg.
45 Deg.
67.5 Deg.
Carriage is
Initialize
Retarder plate is out of
TCS Status Display (v1.53)
2022-04-21 20:24:49 Tracking Focus 27315+100
ST 9:12:53 Guiding 3.0 CCD Pro Park
RA 11:01:13 Rot -175.79 CCD Filt 4: R_Bes641_14
DEC 29:37:47 FRot 90.00 Guide X 180396
Guide Errors Guide Intensity Fiber Guider
XY Guide
Reset Scaling option: 1.0 arcsec 5 min
Sequencer (alfosc)
[1] 23155
[2] 23156
[3] 23157
[4] 23158
Restoring ALFOSCAUX state 'snapshot' (2022-04-21 20:18:49)
Restoring ALFOSC state 'snapshot' (2022-04-21 20:18:49)
Restoring FASU state 'snapshot' (2022-04-21 20:18:50)
Restoring CCD14 state 'snapshot' (2022-04-21 20:18:50)
[4] + Done system.restore CCD14 snapshot
[3] + Done system.restore FASU snapshot
[2] + Done system.restore ALFOSCAUX snapshot
[1] + Done system.restore ALFOSC snapshot
-->Applying final telescope focus value 27318...
-->Applying the filter focus offset value...
Applying a focus offset of 100 units
[1] 23308
[1] Done tcs.focus-delta 100
Done.
[obs@selena ~][20:22][ALFOSC]$ bin 1 1
[obs@selena ~][20:23][ALFOSC]$
ALFOSC Run Selector (2022-04-21)
Observer: group5
Run: 65-702 Manuel Linares
65-702 Manuel Linares
Sequencer (alfosc)
access control disabled, clients can connect from any host
[obs@selena ~][19:25][ALFOSC]$ tel-offset
tel-offset: Command not found.
[obs@selena ~][DING!][ALFOSC]$ teloffset 10 0
code= 414605037 ip= 161.72.5.7 X=10 y= 0
Moving the telescope...
[obs@selena ~][20:00][ALFOSC]$ teloffset 10 0
code= 414605037 ip= 161.72.5.7 X=10 y= 0
Moving the telescope...
[obs@selena ~][20:01][ALFOSC]$ teloffset 10 0
code= 414605037 ip= 161.72.5.7 X=10 y= 0
Moving the telescope...
[obs@selena ~][20:02][ALFOSC]$
lisa.not.iac.es:5913 (x11) - VNC Viewer
OSC CCD3 Status Display
Metrics Engineering Debug
Idle Time left: 0
Time: 10 Multi Exp.: 0 / 0
100%
100%
ometry
etector size: 2148x2102
indow starts: (1, 1) (blue dot)
indow dimensions: 2148x2102
Binning 1:1 Overscan 50:38
Output
AutoSave: ON
File: /images/ALFd210067.fits
Amplifier: D
Pix. speed: 200
RON: n.a.
Auto Shutter: On
Status Delay: -0.257s
NOT Specific
Object: Focuspyr
Observer: group5
Remote AutoSave: OFF
Remote Path: elena:/data/service/calib/

OBSERVATIONAL ASTROPHYSICS

Project reports

Optical photometry on cataclysmic variables.

Karine Halleraker[a], Oda Hjemli[a], Elise L. Hanssen[a]

[a]*Institutt for fysikk, Norges Teknisk-Naturvitenskapelige Universitet, N-7491 Trondheim, Norway.*

Thursday 26th May, 2022

Abstract

We present the optical photometry of
the r- and g-band. By performing diffe
for both targets. We assume this to be
temperatures were found to be 8800
$\approx 17.1kpc$.

Optical photometry of AM Her 1RXS J161008.0+035222 to determine the orbital period and spectral type

Kjell Heinrich,[1] Tea Christiansen Rasmussen[1] Melissa Silva,[1]
[1]*Institutt for Fysikk, Norwegian University of Science and Technology, N-7491 Trondheim, Norway.*

26. May 2022

ABSTRACT
We present the findings of a photometric study of 1R
are systems without an accretion disc and with a stro
the orbital period. Analyzing the data points of the
orbital period to be $P_{orb} = 0.1363 \pm 0.001$ days, whi
the effective temperature of the system is $T_{eff} = 41$
radial distance to the polar was calculated to be $d =$

Optical photometry of the redback millisecond pulsar PSR J1622-0315

Marco Turchetta,[1]★
[1]*Department of Physics, Norwegian University of Science and Technology, Høgskoleringen 5, NO-7491 Trondheim, Norway*

Accepted XXX. Received YYY; in original form ZZZ

ABSTRACT
We present the first multi-band optical light curv
obtained by performing differential photometry i
orbital period $P_{orb} = 3.9$ h of the system, we iden
$\phi = 0.25$ and $\phi = 0.75$ and minima around $\phi = 0.$
shape of the companion star, which is tidally disto
i') are compatible with little temperature changes
of the companion's inner face by the pulsar wind is
usually observe in other redback pulsars. We disc
of the redback millisecond pulsar 3FGL J0212.1+
and amplitudes of the same order $\Delta m \simeq 0.2$ mag w
$i \simeq 69°$ of 3FGL J0212.1+5320, we provide a rou
result obtained in a previous work on this redback

Tick-Tock Goes The Black Hole Clock

P. A. Sevle, F. A. Quinton

[1]Department of Physics, Norwegian University of Science and Technology, NO-7491 Trondheim, Norway.

May 25, 2022

Supermassive Black Hol
the resolution limit of curr
been proposed to date. Or
has a well sampled light cu
amplitude over the last fe
tick-tock source taken witl
discuss these in the light o
the proposed merger[1] ha
explanations of the obscure

State determination of the transitional binary millisecond pulsar PSR J1023+0038

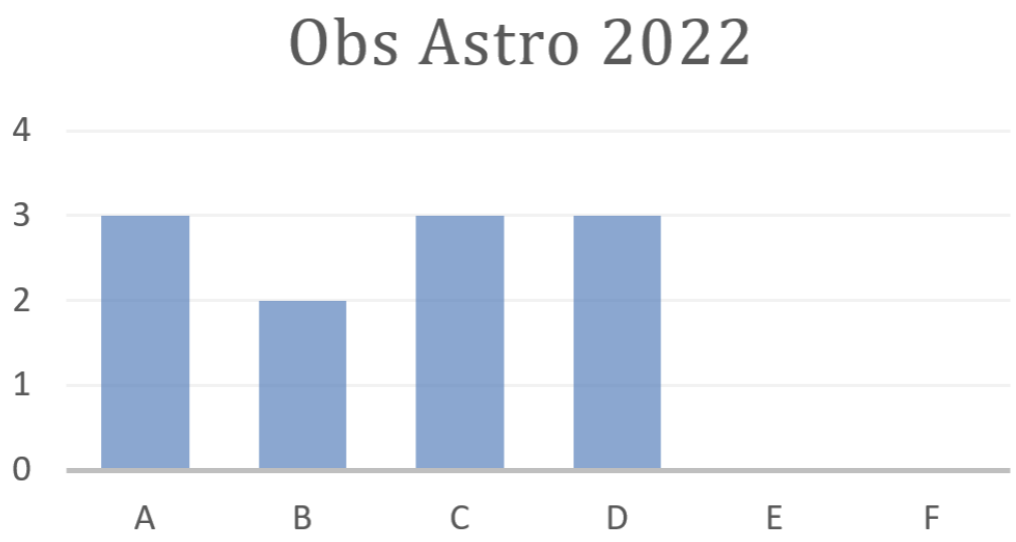
Sindre S. Lindseth,[1] and Anders Tidemann[1]
[1]*Department of Physics, Norwegian University of Science and Technology*

26 May 2022

ABSTRACT
In the following article we present optical spectroscopy and photometry performed on the transitional millisecond pulsar PSR J1023+0038 which was observed with the Nordic Optical Telescope during a four hour observation period the night of April 20th 2022. The motivation for the observations was to conclude the state of the system and we provide spectroscopic and photometric evidence that the system still is in the accretion disk state, as it has been since transitioning from the pulsar state in 2013.

OBSERVATIONAL ASTROPHYSICS

Feedback



What was the best part of the course?

3 responses

Astro lab sessions and observing project

The observations with the NOT. Probably the coolest thing I have done in my almost 4 years of higher education.

Learning to understand and work with different data programs used in astrophysics

What was the worst part of the course?

3 responses

Not going to La Palma physically :-)

The work load of P5.1 was quite large compared to the other AstroLabs. Other than that it would be nice to have exercise sessions in the future courses, where one can work on the exercises with guidance from a student assistant. This way you can get help if you are stuck, instead of having the answers showed to you in lectures. This could also lead to more time to add more content to the class as well.

Very time consuming

OBSERVATIONAL ASTROPHYSICS

Summary

- **OBSERVATIONAL ASTROPHYSICS**

Norwegian University of Science and Technology
Trondheim, Norway

- **THREE-PRONGED APPROACH:**
  - **Lectures**
  - **Data analysis labs**
  - **Observing project at the Nordic Optical Telescope**

- **BACK IN 2023A!**
- **THANKS a L/NOT!**