Procedural guide in the tutorial session

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1. Sample data

The data was obtained by near-infrared multi-object spectroscopic observations for high-redshift star-forming galaxies, which is conducted with MOIRCS on the Subaru Telescope (Yoshikawa, T., et al. 2010, ApJ, 718, 112).

2. Procedure

09:30-12:30 Practice of data analysis
12:30-13:30 Lunch
13:30-17:00 Practice of data analysis
18:00- Banquet

If you understand the yesterday's lecture well, begin and proceed an exercise (from chapter 4.1) according to the handbook of data reduction school. If you do not, first read the chapter 2 of the handbook.

In each process, **be sure to verify the processed images on ds9** and take care to check the difference between before/after images. For interpolation of cosmic ray, a significant difference would not be found.

3. Points to be checked

If you achieve the following goals, get it looked at by lecturers and then go to the next step after the pass.

- Extraction of a slit from reduced spectra images (section 4.3)
- Combine of spectra (section 4.5)
- Reduction of a standard star spectrum (section 4.6)
- Measurement of redshift (section 5.1)

After you complete the all tasks, continuously analyze other slits.

4. Command log

At first, **you should try to do the data reduction without following helps**. When you have a trouble doing, the following logs would be useful for you.

# 4.1 Preparation of the data

cd /home/subaru_tutor02/scratch/
mkdir username
cd username
tar jxf /home/subaru_tutor02/scratch/subaru_sample_data/
MCSMDP_sample.tbz

cp MCSMDP_sample/*.* .
subaru_setup
ds9 &
mcsmdp
mcsmdp

hselect MCSA*.fits $I,OBS-MOD,DATA-TYP,OBJECT,DISPERSR yes

hselect MCSA*.fits $I "OBJECT = 'DOMEFLAT' & @'DET-ID' = 1" > flat1.lst
hselect MCSA*.fits $I "OBJECT = 'DOMEFLAT' & @'DET-ID' = 2" > flat2.lst

hselect MCSA*.fits $I "OBJECT = 'CDFN_MASK02' & @'DET-ID' = 1 & K_DITCNT = 1" > obj1a.lst
hselect MCSA*.fits $I "OBJECT = 'CDFN_MASK02' & @'DET-ID' = 1 & K_DITCNT = 2" > obj1b.lst
hselect MCSA*.fits $I "OBJECT = 'CDFN_MASK02' & @'DET-ID' = 2 & K_DITCNT = 1" > obj2a.lst
hselect MCSA*.fits $I "OBJECT = 'CDFN_MASK02' & @'DET-ID' = 2 & K_DITCNT = 1" > obj2b.lst

# 4.2.1 Making the dome flat and the flat fielding

imcombine @flat1.lst HK500_CDFN2_Domeflat1.fits combine=median reject=sigclip scale=exposure expname=EXPTIME
imcombine @flat2.lst HK500_CDFN2_Domeflat2.fits combine=median reject=sigclip scale=exposure expname=EXPTIME

imarith HK500_CDFN2_Domeflat1.fits / 10000. HK500_CDFN2_Domeflat1.fits
imarith HK500_CDFN2_Domeflat2.fits / 10000. HK500_CDFN2_Domeflat2.fits

!sed 's/\(.*\)/fl\1/' obj1a.lst > flobj1a.lst
imarith @obj1a.lst / HK500_CDFN2_Domeflat1.fits @flobj1a.lst
!sed 's/\(.*\)/fl\1/' obj1b.lst > flobj1b.lst
imarith @obj1b.lst / HK500_CDFN2_Domeflat1.fits @flobj1b.lst

# 4.2.2 Bad pixels and cosmic rays detection/interpolation

!sed 's/\(.*\)\./fits/BPM/\1.pl/' obj1a.lst > bpm1a.lst
!sed 's/\(.*\)\./fits/BPM/\1.pl/' obj1b.lst > bpm1b.lst
mkdir BPM
imcopy mdpdb$bmp/nlbpm1_FF64r.fits,mdpdb$bmp/nlbpm1_FF64r.fits,mdpdb$bmp/nlbpm1_FF64r.fits,mdpdb$bmp/nlbpm1_FF64r.fits @bmp1a.lst
imcopy mdpdb$bmp/nlbpm1_FF64r.fits,mdpdb$bmp/nlbpm1_FF64r.fits,mdpdb$bmp/nlbpm1_FF64r.fits,mdpdb$bmp/nlbpm1_FF64r.fits @bmp1b.lst

craverage @flobj1a.lst "" crmask=@bmp1a.lst average="" sigma="" navg=5 nrej=30 nsig=10 lcrsig=100 hcrsig=10
craverage @flobj1b.lst "" crmask=@bpm1b.lst average="" sigma="" navg=5 nrej=30 nsig=10 lcrsig=100 hcrsig=10

!sed 's/\(.*\)/cr\1/' flobj1a.lst > crobj1a.lst
!sed 's/\(.*\)/cr\1/' flobj1b.lst > crobj1b.lst
imcopy @flobj1a.lst @crobj1a.lst
imcopy @flobj1b.lst @crobj1b.lst
fixpix @crobj1a.lst @bpm1a.lst cinterp=1
fixpix @crobj1b.lst @bpm1b.lst cinterp=1

# (cosmic rays detection/interpolation)
# !sed 's/\(.*\)/cr2\1/' flobj1a.lst > cr2obj1a.lst
# !sed 's/\(.*\)/cr2\1/' flobj1b.lst > cr2obj1b.lst
# crrejection @flobj1a.lst @flobj1b.lst @cr2obj1a.lst @cr2obj1b.lst mdpdb $bpm/nlbpm1_FF64r.fits bpmdir="BPM2" navg=15 nrej=100 nsig=10 lcrsig=100 hcrsig=10

# 4.2.3 Sky subtraction
!sed 's/\(.*\)/ab\1/' crobj1a.lst > abobj1a.lst
imarith @crobj1a.lst - @crobj1b.lst @abobj1a.lst

# 4.2.4 Distortion correction
!sed 's/\(.*\)/gc\1/' abobj1a.lst > gcobj1a.lst
getrans @abobj1a.lst @gcobj1a.lst mdpdb$geomap/mcsdistcrr1_feb07new.dbs mcsdistcrr1_feb07new.gmp boundary=constant

# 4.3 Extraction of slit
maskplot CDFN_MASK02.mdp image=gcabcrflMCSA00057147.fits raw+

!sed 's/\(.*\)\..fits/\1_MODS11-0390\..fits/' gcobj1a.lst > gcMODS11-0390.lst
!sed 's/\(.*\)/[*,1755:1840]/' gcobj1a.lst > cut.lst
imcopy @cut.lst @gcMODS11-0390.lst

# 4.4 Individual processing
# 4.4.1 Wavelength calibration
!sed 's/\(.*\)/gcsky\1/' crobj1a.lst > gcsky1a.lst
getrans @crobj1a.lst @gcsky1a.lst mdpdb$geomap/mcsdistcrr1_feb07new.dbs mcsdistcrr1_feb07new.gmp boundary=constant
!sed 's/\(.*\)\..fits/\1_MODS11-0390\..fits/' gcsky1a.lst > gcskyMODS11-0390.lst
!sed 's/\(.*\)/[*,1755:1840]/' gcsky1a.lst > cut.lst
imcopy @cut.lst @gcskyMODS11-0390.lst
identify gcskycrflMCSA00057147_MODS11-0390.fits coordlist=mpdb$ohlist/list_NS_HK500 nsum=20 fwidth=8.0 function=chebyshev order=4 niterate=10
reidentify gcskycrflMCSA00057147_MODS11-0390.fits gcskycrflMCSA00057147_MODS11-0390.fits override=yes step=20 nsum=20 nlost=10 coordlist=mpdb$ohlist/list_NS_HK500 verbose=yes
fitcoords gcskycrflMCSA00057147_MODS11-0390 xorder=4 yorder=3
!sed 's/(.*))/tr\1/' gcMODS11-0390.lst > trMODS11-0390.lst
transform @gcMODS11-0390.lst @trMODS11-0390.lst
gcskycrflMCSA00057147_MODS11-0390 intertype=linear
# 4.4.2 Removal of residual sky emission
!sed 's/(.*))/bg\1/' trMODS11-0390.lst > bgMODS11-0390.lst
background @trMODS11-0390.lst @bgMODS11-0390.lst
# 4.5 Combine of the spectra
hselect @bgMODS11-0390.lst "$I,K_DITWID" yes
!sed 's/(.*))/sh\1/' bgMODS11-0390.lst > shMODS11-0390.lst
imshift @bgMODS11-0390.lst @shMODS11-0390.lst 0 26
!sed 's/(.*))/ng\1/' shMODS11-0390.lst > ngMODS11-0390.lst
imarith @shMODS11-0390.lst * -1 @ngMODS11-0390.lst
imcombine @bgMODS11-0390.lst,@ngMODS11-0390.lst HK500_MODS11-0390 combine=median reject=sigclip scale=exposure weight=exposure expname=EXPTIME
# 4.6 Flux calibration and telluric correction
hselect MCSA*.fits $I "OBJECT = 'M53735(A0V:J8.9:H8.9:K8.9)''
imarith MCSA00057114.fits / HK500_CDFN2_Domeflat2.fits flMCSA00057114.fits
imarith MCSA00057116.fits / HK500_CDFN2_Domeflat2.fits flMCSA00057116.fits
imcopy mdpdb$bpm/nlbpm2_FF64r.fits BPM/MCSA00057114.pl
imcopy mdpdb$bpm/nlbpm2_FF64r.fits BPM/MCSA00057116.pl
craverage flMCSA00057114.fits '"' crmask=BPM/MCSA00057114.pl average=""
sigma="" navg=5 nrej=30 nsig=10 lcrsig=100 hcrsig=10
craverage flMCSA00057116.fits '"' crmask=BPM/MCSA00057116.pl average=""
sigma="" navg=5 nrej=30 nsig=10 lcrsig=100 hcrsig=10
imcopy flMCSA00057114.fits crfMCSA00057114.fits
imcopy flMCSA00057116.fits crfMCSA00057116.fits
fixpix crfMCSA00057114.fits BPM/MCSA00057114.pl cinterp=1
fixpix crfMCSA00057116.fits BPM/MCSA00057116.pl cinterp=1

imarith crfMCSA00057114.fits - crfMCSA00057116.fits
abcrfMCSA00057114.fits
gecom crafMCSA00057114.fits gcskycrafMCSA00057114.fits mdpdb$geomap/mcsmv20007new.dbs mcsmv20007new.gmp boundary=constant
imcopy gcskycrafMCSA00057114.fits[*,902:1022]
gcskycrafMCSA00057114_M53735.fits
gecom crafMCSA00057114.fits gcskycrafMCSA00057114.fits mdpdb$geomap/mcsmv20007new.dbs mcsmv20007new.gmp boundary=constant
imcopy gcskycrafMCSA00057114.fits[*,902:1022]
gcskycrafMCSA00057114_M53735.fits

identify gcskycrafMCSA00057114_M53735.fits coordlist=mdpdb$ohlist/list_NS_HK500 nsum=20 fwidth=8.0 function=chebyshev order=4 niterate=10
reidentify gcskycrafMCSA00057114_M53735.fits
gcskycrafMCSA00057114_M53735.fits override=yes step=20 nsum=20
nlost=20 coordlist=mdpdb$ohlist/list_NS_HK500 verbose=yes

fitcoords gcskycrafMCSA00057114_M53735.fits xorder=4 yorder=3
transform gcskycrafMCSA00057114_M53735.fits
trgcbcrfMCSA00057114_M53735.fits gcskycrafMCSA00057114_M53735
interptype=linear

background trgcbcrfMCSA00057114_M53735.fits
bgtrgcbcrfMCSA00057114_M53735.fits axis=2 order=3 low_reject=3
high_reject=3 niterate=3
hselect bgtrgcbcrfMCSA00057114_M53735.fits "$I,K_DITWID" yes

imshift bgtrgcbcrfMCSA00057114_M53735.fits
shbgtrgcbcrfMCSA00057114_M53735.fits 0 43
imarith shbgtrgcbcrfMCSA00057114_M53735.fits * -1
ngshbgtrgcbcrfMCSA00057114_M53735.fits
imcombine
bgtrgcbcrfMCSA00057114_M53735.fits,ngshbgtrgcbcrfMCSA00057114_M53735.fits HK500_M53735 combine=median reject=sigclip scale=exposure
weight=exposure expname=EXPTIME

apall HK500_M53735.fits
rescurve HK500_M53735.ms.fits 8.856 resc_CDFN2_HK500.fits
mdpfcalib HK500_MODS11-0390.fits resc_CDFN2_HK500.fits
HK500_MODS11-0390fl.fits

# 5.1 Measurement of redshift
splot HK500_MODS11-0390fl.fits 41