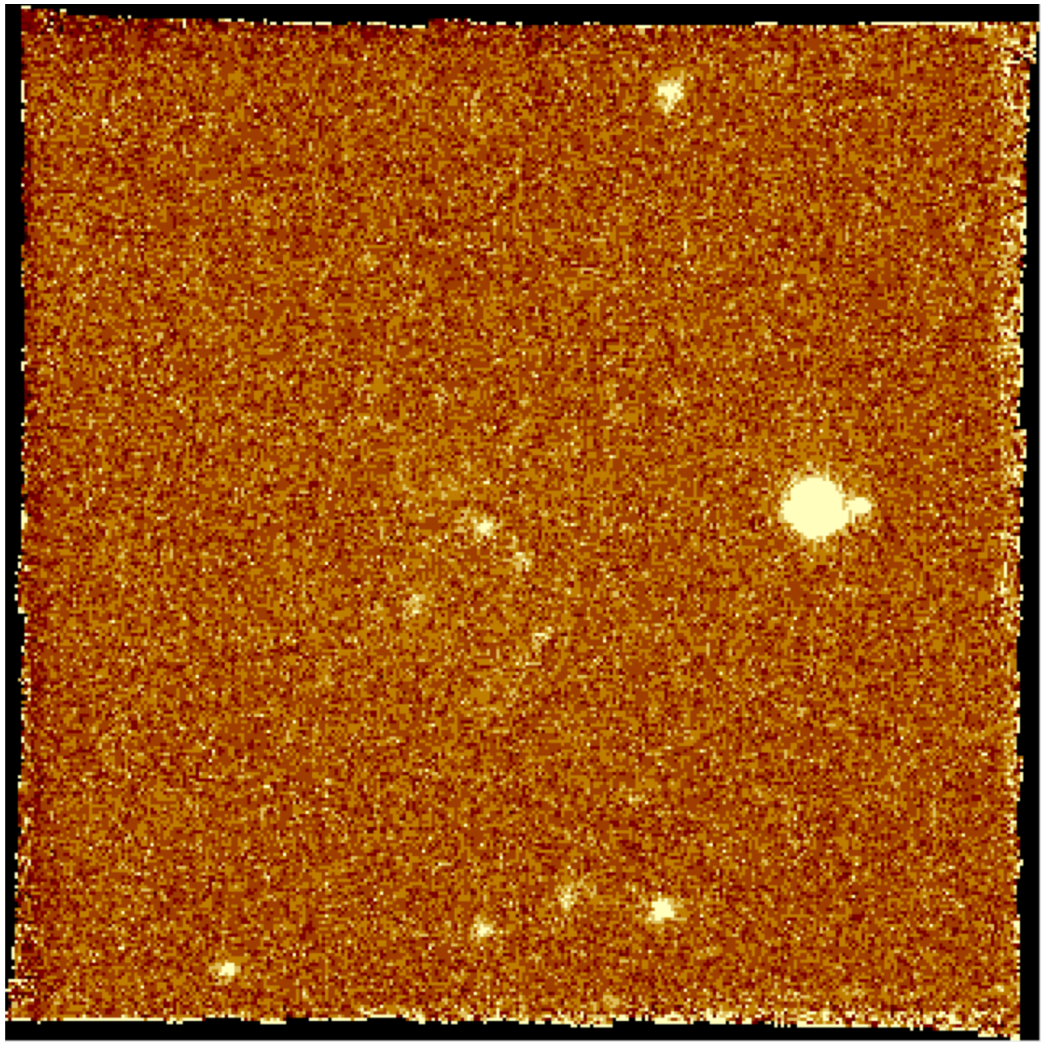
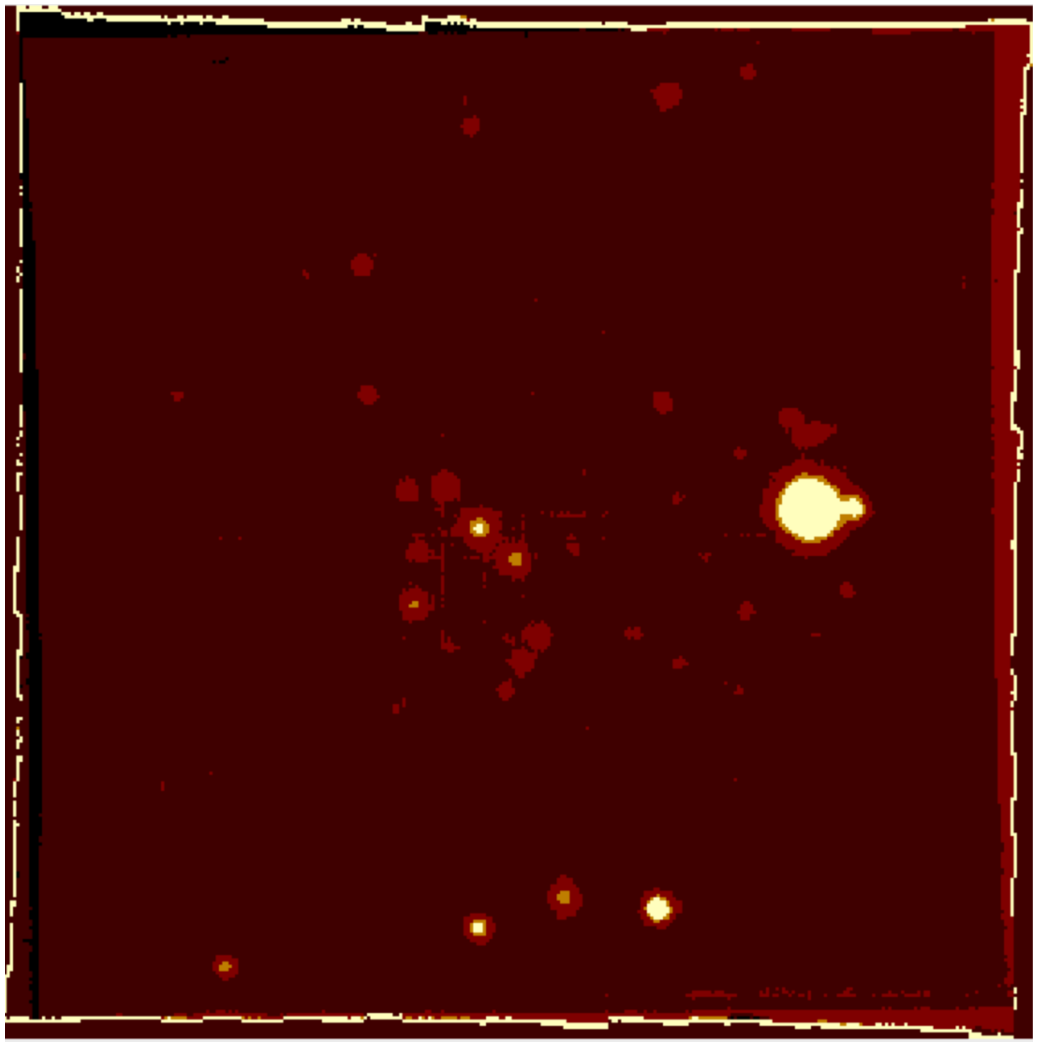
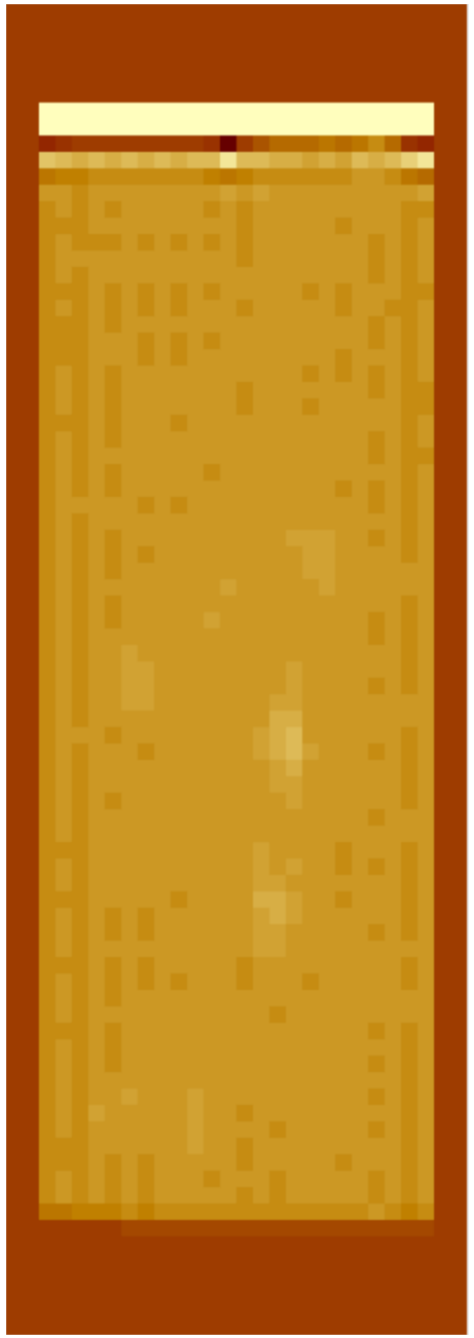
Spectral Cube Shenanigans

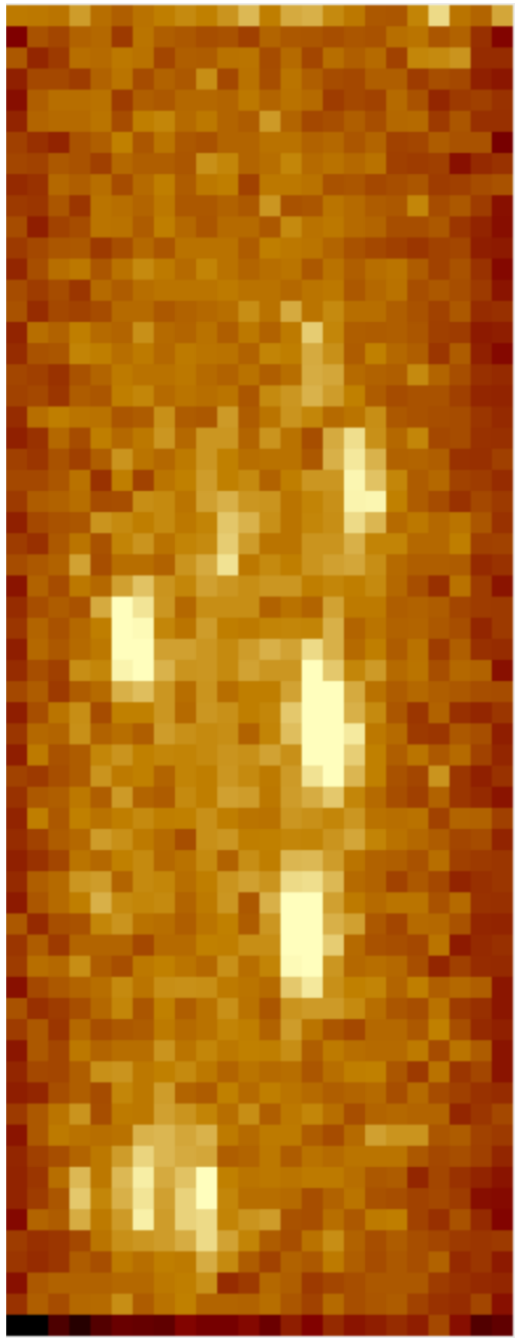
Examples (MUSE)





Example (KCWI)





QFitsView Intermission

(+ quick ds9 remark)

Metainformation

```
WAVALL0 =                 4861 / Low inclusive wavelength
WAVALL1 =                 5336 / High inclusive wavelength
WAVGOOD0=    4859.751032916362 / Low good wavelength
WAVGOOD1=    5337.463081480892 / High good wavelength
WAVMID  =    5098.594534348915 / middle wavelength
```

```
NAXIS   =                    3
NAXIS1  =                   24
NAXIS2  =                   63
NAXIS3  =                 1901

OBJECT  = 'NGC5846-UDG1'       / Object name
OBSERVER= 'Various '           / Observer name
INSTRUME= 'KCWI    '           / Instrument
CAMERA  = 'BLUE    '           / Camera (blue,red,fpc)
IMTYPE  = 'OBJECT  '           / Image type
GROUPID = '2019-03-31-52'      / Group ID

CURRINST= 'KCWI    '           / DCS Instrument
TARGNAME= 'NGC5846-UDG1'       / DCS Target name
PONAME  = 'IFU     '           / DCS Point origin name
RA      = '15:05:20.31'        / DCS RA
DEC     = '+01:48:49.0'        / DCS Dec
TARGRA  = '15:05:20.46'        / DCS Target RA
TARGDEC = '+01:48:45.6'        / DCS Target Dec

UNCSTD  =                    T / stddev uncertainty created?
IMGRECT =                    T / Image rectified?
DARKSUB =                    F / master dark subtracted?
SCATSUB =                    T / was scattered light subtracted?
FLATCOR =                    T / flat corrected?
MFFILE  = 'kb190331_00040_mflat.fits' / Master flat filename
SKYCOR  =                    F / sky corrected?
GEOMCOR =                    T / Geometry corrected?
```

```
IFUPA   =                60.02 / IFU position angle (degrees)
IFUROFF =                  0.0 / IFU-SKYPA offset (degrees)
WCSDIM  =                    3 / number of dimensions in WCS
WCSNAME = 'KCWI    '
RADESYS = 'FK5     '
CTYPE1  = 'RA---TAN'
CTYPE2  = 'DEC--TAN'
CTYPE3  = 'AWAV    '           / Air Wavelengths
CUNIT1  = 'deg     '           / RA units
CUNIT2  = 'deg     '           / DEC units
CUNIT3  = 'Angstrom'           / Wavelength units
CNAME1  = 'KCWI RA '           / RA name
CNAME2  = 'KCWI DEC'           / DEC name
CNAME3  = 'KCWI Wavelength'    / Wavelength name
CRVAL1  =           226.334625 / RA zeropoint
CRVAL2  =  1.8136111111111111 / DEC zeropoint
CRVAL3  =              4808.25 / Wavelength zeropoint
CRPIX1  =                 14.5 / RA reference pixel
CRPIX2  =                 43.0 / DEC reference pixel
CRPIX3  =               -210.0 / Wavelength reference pixel
CD1_1   = -9.4237983519361E-05 / RA degrees per column pixel
CD2_1   = 0.000163356636113151 / DEC degrees per column pixel
CD1_2   = 7.012754260417 17E-05 / RA degrees per row pixel
CD2_2   = 4.045552333489 30E-05 / DEC degrees per row pixel
CD3_3   =                 0.25 / Wavelength Angstroms per pixel
```

```
PXSCL   =          8.096E-05 / Pixel scale along slice (deg)
SLSCL   =        0.00018859 / Pixel scale perp. to slices (deg)
```

Metainformation

```
NAXIS   =                    3
NAXIS1  =                   24
NAXIS2  =                   63
NAXIS3  =                 1901
```

```
OBJECT  = 'NGC5846-UDG1'       / Object name
OBSERVER= 'Various '           / Observer name
INSTRUME= 'KCWI    '           / Instrument
CAMERA  = 'BLUE    '           / Camera (blue,red,fpc)
IMTYPE  = 'OBJECT  '           / Image type
GROUPID = '2019-03-31-52'      / Group ID
```

```
CURRINST= 'KCWI    '           / DCS Instrument
TARGNAME= 'NGC5846-UDG1'       / DCS Target name
PONAME  = 'IFU     '           / DCS Point origin name
RA      = '15:05:20.31'        / DCS RA
DEC     = '+01:48:49.0'        / DCS Dec
TARGRA  = '15:05:20.46'        / DCS Target RA
TARGDEC = '+01:48:45.6'        / DCS Target Dec
```

```
UNCSTD  =                    T / stddev uncertainty created?
IMGRECT =                    T / Image rectified?
DARKSUB =                    F / master dark subtracted?
SCATSUB =                    T / was scattered light subtracted?
FLATCOR =                    T / flat corrected?
MFFILE  = 'kb190331_00040_mflat.fits' / Master flat filename
SKYCOR  =                    F / sky corrected?
GEOMCOR =                    T / Geometry corrected?
```

```
WAVALL0 =                 4861 / Low inclusive wavelength
WAVALL1 =                 5336 / High inclusive wavelength
WAVGOOD0=    4859.751032916362 / Low good wavelength
WAVGOOD1=    5337.463081480892 / High good wavelength
WAVMID  =    5098.594534348915 / middle wavelength
```

```
IFUPA   =                60.02 / IFU position angle (degrees)
IFUROFF =                  0.0 / IFU-SKYPA offset (degrees)
WCSDIM  =                    3 / number of dimensions in WCS
WCSNAME = 'KCWI    '
RADESYS = 'FK5     '
CTYPE1  = 'RA---TAN'
CTYPE2  = 'DEC--TAN'
CTYPE3  = 'AWAV    '           / Air Wavelengths
CUNIT1  = 'deg     '           / RA units
CUNIT2  = 'deg     '           / DEC units
CUNIT3  = 'Angstrom'           / Wavelength units
CNAME1  = 'KCWI RA '           / RA name
CNAME2  = 'KCWI DEC'           / DEC name
CNAME3  = 'KCWI Wavelength'    / Wavelength name
CRVAL1  =           226.334625 / RA zeropoint
CRVAL2  =  1.8136111111111111 / DEC zeropoint
CRVAL3  =              4808.25 / Wavelength zeropoint
CRPIX1  =                 14.5 / RA reference pixel
CRPIX2  =                 43.0 / DEC reference pixel
CRPIX3  =               -210.0 / Wavelength reference pixel
CD1_1   = -9.4237983519361E-05 / RA degrees per column pixel
CD2_1   = 0.000163356636113151 / DEC degrees per column pixel
CD1_2   = 7.012754260417 17E-05 / RA degrees per row pixel
CD2_2   = 4.045552333489 30E-05 / DEC degrees per row pixel
CD3_3   =                 0.25 / Wavelength Angstroms per pixel
```

```
PXSCL   =          8.096E-05 / Pixel scale along slice (deg)
SLSCL   =        0.00018859 / Pixel scale perp. to slices (deg)
```

Metainformation

```
NAXIS   =                    3
NAXIS1  =                   24
NAXIS2  =                   63
NAXIS3  =                 1901
```

```
OBJECT  = 'NGC5846-UDG1'       / Object name
OBSERVER= 'Various '           / Observer name
INSTRUME= 'KCWI    '           / Instrument
CAMERA  = 'BLUE    '           / Camera (blue,red,fpc)
IMTYPE  = 'OBJECT  '           / Image type
GROUPID = '2019-03-31-52'      / Group ID
```

```
CURRINST= 'KCWI    '           / DCS Instrument
TARGNAME= 'NGC5846-UDG1'       / DCS Target name
PONAME  = 'IFU     '           / DCS Point origin name
RA      = '15:05:20.31'        / DCS RA
DEC     = '+01:48:49.0'        / DCS Dec
TARGRA  = '15:05:20.46'        / DCS Target RA
TARGDEC = '+01:48:45.6'        / DCS Target Dec
```

```
UNCSTD  =                    T / stddev uncertainty created?
IMGRECT =                    T / Image rectified?
DARKSUB =                    F / master dark subtracted?
SCATSUB =                    T / was scattered light subtracted?
FLATCOR =                    T / flat corrected?
MFFILE  = 'kb190331_00040_mflat.fits' / Master flat filename
SKYCOR  =                    F / sky corrected?
GEOMCOR =                    T / Geometry corrected?
```

```
WAVALL0 =                 4861 / Low inclusive wavelength
WAVALL1 =                 5336 / High inclusive wavelength
WAVGOOD0=    4859.751032916362 / Low good wavelength
WAVGOOD1=    5337.463081480892 / High good wavelength
WAVMID  =    5098.594534348915 / middle wavelength
```

```
IFUPA   =                60.02 / IFU position angle (degrees)
IFUROFF =                  0.0 / IFU-SKYPA offset (degrees)
WCSDIM  =                    3 / number of dimensions in WCS
WCSNAME = 'KCWI    '
RADESYS = 'FK5     '
CTYPE1  = 'RA---TAN'
CTYPE2  = 'DEC--TAN'
CTYPE3  = 'AWAV    '           / Air Wavelengths
CUNIT1  = 'deg     '           / RA units
CUNIT2  = 'deg     '           / DEC units
CUNIT3  = 'Angstrom'           / Wavelength units
CNAME1  = 'KCWI RA '           / RA name
CNAME2  = 'KCWI DEC'           / DEC name
CNAME3  = 'KCWI Wavelength'    / Wavelength name
CRVAL1  =           226.334625 / RA zeropoint
CRVAL2  =  1.8136111111111111 / DEC zeropoint
CRVAL3  =              4808.25 / Wavelength zeropoint
CRPIX1  =                 14.5 / RA reference pixel
CRPIX2  =                 43.0 / DEC reference pixel
CRPIX3  =               -210.0 / Wavelength reference pixel
CD1_1   = -9.4237983519361E-05 / RA degrees per column pixel
CD2_1   = 0.000163356636113151 / DEC degrees per column pixel
CD1_2   = 7.012754260417 17E-05 / RA degrees per row pixel
CD2_2   = 4.045552333489 30E-05 / DEC degrees per row pixel
CD3_3   =                 0.25 / Wavelength Angstroms per pixel
```

```
PXSCL   =          8.096E-05 / Pixel scale along slice (deg)
SLSCL   =        0.00018859 / Pixel scale perp. to slices (deg)
```

Metainformation

```
WAVALL0 =                 4861 / Low inclusive wavelength
WAVALL1 =                 5336 / High inclusive wavelength
WAVGOOD0=    4859.751032916362 / Low good wavelength
WAVGOOD1=    5337.463081480892 / High good wavelength
WAVMID  =    5098.594534348915 / middle wavelength
```

```
NAXIS   =                    3
NAXIS1  =                   24
NAXIS2  =                   63
NAXIS3  =                 1901
```

```
OBJECT  = 'NGC5846-UDG1'       / Object name
OBSERVER= 'Various '           / Observer name
INSTRUME= 'KCWI    '           / Instrument
CAMERA  = 'BLUE    '           / Camera (blue,red,fpc)
IMTYPE  = 'OBJECT  '           / Image type
GROUPID = '2019-03-31-52'      / Group ID
```

```
CURRINST= 'KCWI    '           / DCS Instrument
TARGNAME= 'NGC5846-UDG1'       / DCS Target name
PONAME  = 'IFU     '           / DCS Point origin name
RA      = '15:05:20.31'        / DCS RA
DEC     = '+01:48:49.0'        / DCS Dec
TARGRA  = '15:05:20.46'        / DCS Target RA
TARGDEC = '+01:48:45.6'        / DCS Target Dec
```

```
UNCSTD  =                    T / stddev uncertainty created?
IMGRECT =                    T / Image rectified?
DARKSUB =                    F / master dark subtracted?
SCATSUB =                    T / was scattered light subtracted?
FLATCOR =                    T / flat corrected?
MFFILE  = 'kb190331_00040_mflat.fits' / Master flat filename
SKYCOR  =                    F / sky corrected?
GEOMCOR =                    T / Geometry corrected?
```

```
IFUPA   =                60.02 / IFU position angle (degrees)
IFUROFF =                  0.0 / IFU-SKYPA offset (degrees)
WCSDIM  =                    3 / number of dimensions in WCS
WCSNAME = 'KCWI    '
RADESYS = 'FK5     '
CTYPE1  = 'RA---TAN'
CTYPE2  = 'DEC--TAN'
CTYPE3  = 'AWAV    '           / Air Wavelengths
CUNIT1  = 'deg     '           / RA units
CUNIT2  = 'deg     '           / DEC units
CUNIT3  = 'Angstrom'           / Wavelength units
CNAME1  = 'KCWI RA '           / RA name
CNAME2  = 'KCWI DEC'           / DEC name
CNAME3  = 'KCWI Wavelength'    / Wavelength name
CRVAL1  =            226.334625 / RA zeropoint
CRVAL2  =   1.8136111111111111 / DEC zeropoint
CRVAL3  =              4808.25 / Wavelength zeropoint
CRPIX1  =                 14.5 / RA reference pixel
CRPIX2  =                 43.0 / DEC reference pixel
CRPIX3  =               -210.0 / Wavelength reference pixel
CD1_1   = -9.4237983519361E-05 / RA degrees per column pixel
CD2_1   = 0.000163356636113151 / DEC degrees per column pixel
CD1_2   = 7.012754260417 17E-05 / RA degrees per row pixel
CD2_2   = 4.045552333489 30E-05 / DEC degrees per row pixel
CD3_3   =                 0.25 / Wavelength Angstroms per pixel
```

```
PXSCL   =          8.096E-05 / Pixel scale along slice (deg)
SLSCL   =        0.00018859 / Pixel scale perp. to slices (deg)
```

Metainformation

```
NAXIS   =                    3
NAXIS1  =                   24
NAXIS2  =                   63
NAXIS3  =                 1901

OBJECT  = 'NGC5846-UDG1'       / Object name
OBSERVER= 'Various '           / Observer name
INSTRUME= 'KCWI    '           / Instrument
CAMERA  = 'BLUE    '           / Camera (blue,red,fpc)
IMTYPE  = 'OBJECT  '           / Image type
GROUPID = '2019-03-31-52'      / Group ID

CURRINST= 'KCWI    '           / DCS Instrument
TARGNAME= 'NGC5846-UDG1'       / DCS Target name
PONAME  = 'IFU     '           / DCS Point origin name
RA      = '15:05:20.31'        / DCS RA
DEC     = '+01:48:49.0'        / DCS Dec
TARGRA  = '15:05:20.46'        / DCS Target RA
TARGDEC = '+01:48:45.6'        / DCS Target Dec

UNCSTD  =                    T / stddev uncertainty created?
IMGRECT =                    T / Image rectified?
DARKSUB =                    F / master dark subtracted?
SCATSUB =                    T / was scattered light subtracted?
FLATCOR =                    T / flat corrected?
MFFILE  = 'kb190331_00040_mflat.fits' / Master flat filename
SKYCOR  =                    F / sky corrected?
GEOMCOR =                    T / Geometry corrected?
```

```
WAVALL0 =                 4861 / Low inclusive wavelength
WAVALL1 =                 5336 / High inclusive wavelength
WAVGOOD0=    4859.751032916362 / Low good wavelength
WAVGOOD1=    5337.463081480892 / High good wavelength
WAVMID  =    5098.594534348915 / middle wavelength
```

```
IFUPA   =                60.02 / IFU position angle (degrees)
IFUROFF =                  0.0 / IFU-SKYPA offset (degrees)
WCSDIM  =                    3 / number of dimensions in WCS
WCSNAME = 'KCWI    '
RADESYS = 'FK5     '
CTYPE1  = 'RA---TAN'
CTYPE2  = 'DEC--TAN'
CTYPE3  = 'AWAV    '           / Air Wavelengths
CUNIT1  = 'deg     '           / RA units
CUNIT2  = 'deg     '           / DEC units
CUNIT3  = 'Angstrom'           / Wavelength units
CNAME1  = 'KCWI RA '           / RA name
CNAME2  = 'KCWI DEC'           / DEC name
CNAME3  = 'KCWI Wavelength'    / Wavelength name
CRVAL1  =           226.334625 / RA zeropoint
CRVAL2  =  1.8136111111111111 / DEC zeropoint
CRVAL3  =              4808.25 / Wavelength zeropoint
CRPIX1  =                 14.5 / RA reference pixel
CRPIX2  =                 43.0 / DEC reference pixel
CRPIX3  =               -210.0 / Wavelength reference pixel
CD1_1   = -9.4237983519361E-05 / RA degrees per column pixel
CD2_1   = 0.000163356636113151 / DEC degrees per column pixel
CD1_2   = 7.012754260417 17E-05 / RA degrees per row pixel
CD2_2   = 4.045552333489 30E-05 / DEC degrees per row pixel
CD3_3   =                 0.25 / Wavelength Angstroms per pixel
```

```
PXSCL   =          8.096E-05 / Pixel scale along slice (deg)
SLSCL   =        0.00018859 / Pixel scale perp. to slices (deg)
```

Metainformation

```
WAVALL0 =                 4861 / Low inclusive wavelength
WAVALL1 =                 5336 / High inclusive wavelength
WAVGOOD0=    4859.751032916362 / Low good wavelength
WAVGOOD1=    5337.463081480892 / High good wavelength
WAVMID  =    5098.594534348915 / middle wavelength
```

```
NAXIS   =                    3
NAXIS1  =                   24
NAXIS2  =                   63
NAXIS3  =                 1901

OBJECT  = 'NGC5846-UDG1'       / Object name
OBSERVER= 'Various '           / Observer name
INSTRUME= 'KCWI    '           / Instrument
CAMERA  = 'BLUE    '           / Camera (blue,red,fpc)
IMTYPE  = 'OBJECT  '           / Image type
GROUPID = '2019-03-31-52'      / Group ID

CURRINST= 'KCWI    '           / DCS Instrument
TARGNAME= 'NGC5846-UDG1'       / DCS Target name
PONAME  = 'IFU     '           / DCS Point origin name
RA      = '15:05:20.31'        / DCS RA
DEC     = '+01:48:49.0'        / DCS Dec
TARGRA  = '15:05:20.46'        / DCS Target RA
TARGDEC = '+01:48:45.6'        / DCS Target Dec

UNCSTD  =                    T / stddev uncertainty created?
IMGRECT =                    T / Image rectified?
DARKSUB =                    F / master dark subtracted?
SCATSUB =                    T / was scattered light subtracted?
FLATCOR =                    T / flat corrected?
MFFILE  = 'kb190331_00040_mflat.fits' / Master flat filename
SKYCOR  =                    F / sky corrected?
GEOMCOR =                    T / Geometry corrected?
```

```
IFUPA   =                60.02 / IFU position angle (degrees)
IFUROFF =                  0.0 / IFU-SKYPA offset (degrees)
WCSDIM  =                    3 / number of dimensions in WCS
WCSNAME = 'KCWI    '
RADESYS = 'FK5     '
CTYPE1  = 'RA---TAN'
CTYPE2  = 'DEC--TAN'
CTYPE3  = 'AWAV    '           / Air Wavelengths
CUNIT1  = 'deg     '           / RA units
CUNIT2  = 'deg     '           / DEC units
CUNIT3  = 'Angstrom'           / Wavelength units
CNAME1  = 'KCWI RA '           / RA name
CNAME2  = 'KCWI DEC'           / DEC name
CNAME3  = 'KCWI Wavelength'    / Wavelength name
CRVAL1  =           226.334625 / RA zeropoint
CRVAL2  =  1.8136111111111111 / DEC zeropoint
CRVAL3  =              4808.25 / Wavelength zeropoint
CRPIX1  =                 14.5 / RA reference pixel
CRPIX2  =                 43.0 / DEC reference pixel
CRPIX3  =               -210.0 / Wavelength reference pixel
CD1_1   = -9.4237983519361E-05 / RA degrees per column pixel
CD2_1   = 0.000163356636113151 / DEC degrees per column pixel
CD1_2   = 7.012754260417 17E-05 / RA degrees per row pixel
CD2_2   = 4.045552333489 30E-05 / DEC degrees per row pixel
CD3_3   =                 0.25 / Wavelength Angstroms per pixel
```

```
PXSCL   =          8.096E-05 / Pixel scale along slice (deg)
SLSCL   =        0.00018859 / Pixel scale perp. to slices (deg)
```

Metainformation

```
WAVALL0 =                 4861 / Low inclusive wavelength
WAVALL1 =                 5336 / High inclusive wavelength
WAVGOOD0=    4859.751032916362 / Low good wavelength
WAVGOOD1=    5337.463081480892 / High good wavelength
WAVMID  =    5098.594534348915 / middle wavelength
```

```
NAXIS   =                    3
NAXIS1  =                   24
NAXIS2  =                   63
NAXIS3  =                 1901
```

```
OBJECT  = 'NGC5846-UDG1'       / Object name
OBSERVER= 'Various '           / Observer name
INSTRUME= 'KCWI    '           / Instrument
CAMERA  = 'BLUE    '           / Camera (blue,red,fpc)
IMTYPE  = 'OBJECT  '           / Image type
GROUPID = '2019-03-31-52'      / Group ID
```

```
CURRINST= 'KCWI    '           / DCS Instrument
TARGNAME= 'NGC5846-UDG1'       / DCS Target name
PONAME  = 'IFU     '           / DCS Point origin name
RA      = '15:05:20.31'        / DCS RA
DEC     = '+01:48:49.0'        / DCS Dec
TARGRA  = '15:05:20.46'        / DCS Target RA
TARGDEC = '+01:48:45.6'        / DCS Target Dec
```

```
UNCSTD  =                    T / stddev uncertainty created?
IMGRECT =                    T / Image rectified?
DARKSUB =                    F / master dark subtracted?
SCATSUB =                    T / was scattered light subtracted?
FLATCOR =                    T / flat corrected?
MFFILE  = 'kb190331_00040_mflat.fits' / Master flat filename
SKYCOR  =                    F / sky corrected?
GEOMCOR =                    T / Geometry corrected?
```

```
IFUPA   =                60.02 / IFU position angle (degrees)
IFUROFF =                  0.0 / IFU-SKYPA offset (degrees)
WCSDIM  =                    3 / number of dimensions in WCS
WCSNAME = 'KCWI    '
RADESYS = 'FK5     '
CTYPE1  = 'RA---TAN'
CTYPE2  = 'DEC--TAN'
CTYPE3  = 'AWAV    '           / Air Wavelengths
CUNIT1  = 'deg     '           / RA units
CUNIT2  = 'deg     '           / DEC units
CUNIT3  = 'Angstrom'           / Wavelength units
CNAME1  = 'KCWI RA '           / RA name
CNAME2  = 'KCWI DEC'           / DEC name
CNAME3  = 'KCWI Wavelength'    / Wavelength name
CRVAL1  =            226.334625 / RA zeropoint
CRVAL2  =  1.8136111111111111 / DEC zeropoint
CRVAL3  =              4808.25 / Wavelength zeropoint
CRPIX1  =                 14.5 / RA reference pixel
CRPIX2  =                 43.0 / DEC reference pixel
CRPIX3  =               -210.0 / Wavelength reference pixel
CD1_1   = -9.4237983519361E-05 / RA degrees per column pixel
CD2_1   = 0.000163356636113151 / DEC degrees per column pixel
CD1_2   = 7.012754260417 17E-05 / RA degrees per row pixel
CD2_2   = 4.045552333489 30E-05 / DEC degrees per row pixel
CD3_3   =                 0.25 / Wavelength Angstroms per pixel
```

```
PXSCL   =          8.096E-05 / Pixel scale along slice (deg)
SLSCL   =        0.00018859 / Pixel scale perp. to slices (deg)
```

Metainformation

```
WAVALL0 =                 4861 / Low inclusive wavelength
WAVALL1 =                 5336 / High inclusive wavelength
WAVGOOD0=    4859.751032916362 / Low good wavelength
WAVGOOD1=    5337.463081480892 / High good wavelength
WAVMID  =    5098.594534348915 / middle wavelength
```

```
NAXIS   =                    3
NAXIS1  =                   24
NAXIS2  =                   63
NAXIS3  =                 1901
```

```
OBJECT  = 'NGC5846-UDG1'       / Object name
OBSERVER= 'Various '           / Observer name
INSTRUME= 'KCWI    '           / Instrument
CAMERA  = 'BLUE    '           / Camera (blue,red,fpc)
IMTYPE  = 'OBJECT  '           / Image type
GROUPID = '2019-03-31-52'      / Group ID
```

```
CURRINST= 'KCWI    '           / DCS Instrument
TARGNAME= 'NGC5846-UDG1'       / DCS Target name
PONAME  = 'IFU     '           / DCS Point origin name
RA      = '15:05:20.31'        / DCS RA
DEC     = '+01:48:49.0'        / DCS Dec
TARGRA  = '15:05:20.46'        / DCS Target RA
TARGDEC = '+01:48:45.6'        / DCS Target Dec
```

```
UNCSTD  =                    T / stddev uncertainty created?
IMGRECT =                    T / Image rectified?
DARKSUB =                    F / master dark subtracted?
SCATSUB =                    T / was scattered light subtracted?
FLATCOR =                    T / flat corrected?
MFFILE  = 'kb190331_00040_mflat.fits' / Master flat filename
SKYCOR  =                    F / sky corrected?
GEOMCOR =                    T / Geometry corrected?
```

```
IFUPA   =                60.02 / IFU position angle (degrees)
IFUROFF =                  0.0 / IFU-SKYPA offset (degrees)
WCSDIM  =                    3 / number of dimensions in WCS
WCSNAME = 'KCWI    '
RADESYS = 'FK5     '
CTYPE1  = 'RA---TAN'
CTYPE2  = 'DEC--TAN'
CTYPE3  = 'AWAV    '           / Air Wavelengths
CUNIT1  = 'deg     '           / RA units
CUNIT2  = 'deg     '           / DEC units
CUNIT3  = 'Angstrom'           / Wavelength units
CNAME1  = 'KCWI RA '           / RA name
CNAME2  = 'KCWI DEC'           / DEC name
CNAME3  = 'KCWI Wavelength'    / Wavelength name
CRVAL1  =           226.334625 / RA zeropoint
CRVAL2  =  1.8136111111111111 / DEC zeropoint
CRVAL3  =              4808.25 / Wavelength zeropoint
CRPIX1  =                 14.5 / RA reference pixel
CRPIX2  =                 43.0 / DEC reference pixel
CRPIX3  =               -210.0 / Wavelength reference pixel
CD1_1   = -9.4237983519361E-05 / RA degrees per column pixel
CD2_1   = 0.000163356636113151 / DEC degrees per column pixel
CD1_2   = 7.012754260417 17E-05 / RA degrees per row pixel
CD2_2   = 4.045552333489 30E-05 / DEC degrees per row pixel
CD3_3   =                 0.25 / Wavelength Angstroms per pixel
```

```
PXSCL   =          8.096E-05 / Pixel scale along slice (deg)
SLSCL   =        0.00018859 / Pixel scale perp. to slices (deg)
```

Metainformation

```
WAVALL0 =                 4861 / Low inclusive wavelength
WAVALL1 =                 5336 / High inclusive wavelength
WAVGOOD0=    4859.751032916362 / Low good wavelength
WAVGOOD1=    5337.463081480892 / High good wavelength
WAVMID  =    5098.594534348915 / middle wavelength
```

```
NAXIS   =                    3
NAXIS1  =                   24
NAXIS2  =                   63
NAXIS3  =                 1901
```

```
OBJECT  = 'NGC5846-UDG1'       / Object name
OBSERVER= 'Various '           / Observer name
INSTRUME= 'KCWI    '           / Instrument
CAMERA  = 'BLUE    '           / Camera (blue,red,fpc)
IMTYPE  = 'OBJECT  '           / Image type
GROUPID = '2019-03-31-52'      / Group ID
```

```
CURRINST= 'KCWI    '           / DCS Instrument
TARGNAME= 'NGC5846-UDG1'       / DCS Target name
PONAME  = 'IFU     '           / DCS Point origin name
RA      = '15:05:20.31'        / DCS RA
DEC     = '+01:48:49.0'        / DCS Dec
TARGRA  = '15:05:20.46'        / DCS Target RA
TARGDEC = '+01:48:45.6'        / DCS Target Dec
```

```
UNCSTD  =                    T / stddev uncertainty created?
IMGRECT =                    T / Image rectified?
DARKSUB =                    F / master dark subtracted?
SCATSUB =                    T / was scattered light subtracted?
FLATCOR =                    T / flat corrected?
MFFILE  = 'kb190331_00040_mflat.fits' / Master flat filename
SKYCOR  =                    F / sky corrected?
GEOMCOR =                    T / Geometry corrected?
```

```
IFUPA   =                60.02 / IFU position angle (degrees)
IFUROFF =                  0.0 / IFU-SKYPA offset (degrees)
WCSDIM  =                    3 / number of dimensions in WCS
WCSNAME = 'KCWI    '
RADESYS = 'FK5     '
CTYPE1  = 'RA---TAN'
CTYPE2  = 'DEC--TAN'
CTYPE3  = 'AWAV    '           / Air Wavelengths
CUNIT1  = 'deg     '           / RA units
CUNIT2  = 'deg     '           / DEC units
CUNIT3  = 'Angstrom'           / Wavelength units
CNAME1  = 'KCWI RA '           / RA name
CNAME2  = 'KCWI DEC'           / DEC name
CNAME3  = 'KCWI Wavelength'    / Wavelength name
CRVAL1  =           226.334625 / RA zeropoint
CRVAL2  =  1.8136111111111111 / DEC zeropoint
CRVAL3  =              4808.25 / Wavelength zeropoint
CRPIX1  =                 14.5 / RA reference pixel
CRPIX2  =                 43.0 / DEC reference pixel
CRPIX3  =               -210.0 / Wavelength reference pixel
CD1_1   = -9.4237983519361E-05 / RA degrees per column pixel
CD2_1   = 0.000163356636113151 / DEC degrees per column pixel
CD1_2   = 7.012754260417 17E-05 / RA degrees per row pixel
CD2_2   = 4.045552333489 30E-05 / DEC degrees per row pixel
CD3_3   =                 0.25 / Wavelength Angstroms per pixel
```

```
PXSCL   =          8.096E-05 / Pixel scale along slice (deg)
SLSCL   =        0.00018859 / Pixel scale perp. to slices (deg)
```

Metainformation

```
WAVALL0 =                 4861 / Low inclusive wavelength
WAVALL1 =                 5336 / High inclusive wavelength
WAVGOOD0=    4859.751032916362 / Low good wavelength
WAVGOOD1=    5337.463081480892 / High good wavelength
WAVMID  =    5098.594534348915 / middle wavelength
```

```
NAXIS   =                    3
NAXIS1  =                   24
NAXIS2  =                   63
NAXIS3  =                 1901

OBJECT  = 'NGC5846-UDG1'       / Object name
OBSERVER= 'Various '           / Observer name
INSTRUME= 'KCWI    '           / Instrument
CAMERA  = 'BLUE    '           / Camera (blue,red,fpc)
IMTYPE  = 'OBJECT  '           / Image type
GROUPID = '2019-03-31-52'      / Group ID

CURRINST= 'KCWI    '           / DCS Instrument
TARGNAME= 'NGC5846-UDG1'       / DCS Target name
PONAME  = 'IFU     '           / DCS Point origin name
RA      = '15:05:20.31'        / DCS RA
DEC     = '+01:48:49.0'        / DCS Dec
TARGRA  = '15:05:20.46'        / DCS Target RA
TARGDEC = '+01:48:45.6'        / DCS Target Dec

UNCSTD  =                    T / stddev uncertainty created?
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DARKSUB =                    F / master dark subtracted?
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FLATCOR =                    T / flat corrected?
MFFILE  = 'kb190331_00040_mflat.fits' / Master flat filename
SKYCOR  =                    F / sky corrected?
GEOMCOR =                    T / Geometry corrected?
```

```
IFUPA   =                60.02 / IFU position angle (degrees)
IFUROFF =                  0.0 / IFU-SKYPA offset (degrees)
WCSDIM  =                    3 / number of dimensions in WCS
WCSNAME = 'KCWI    '
RADESYS = 'FK5     '
CTYPE1  = 'RA---TAN'
CTYPE2  = 'DEC--TAN'
CTYPE3  = 'AWAV    '           / Air Wavelengths
CUNIT1  = 'deg     '           / RA units
CUNIT2  = 'deg     '           / DEC units
CUNIT3  = 'Angstrom'           / Wavelength units
CNAME1  = 'KCWI RA '           / RA name
CNAME2  = 'KCWI DEC'           / DEC name
CNAME3  = 'KCWI Wavelength'    / Wavelength name
CRVAL1  =            226.334625 / RA zeropoint
CRVAL2  =  1.8136111111111111 / DEC zeropoint
CRVAL3  =              4808.25 / Wavelength zeropoint
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CRPIX3  =               -210.0 / Wavelength reference pixel
CD1_1   = -9.4237983519361E-05 / RA degrees per column pixel
CD2_1   = 0.0001633566636113151 / DEC degrees per column pixel
CD1_2   = 7.01275426041717E-05 / RA degrees per row pixel
CD2_2   = 4.04555233348930E-05 / DEC degrees per row pixel
CD3_3   =                0.25 / Wavelength Angstroms per pixel
```

```
PXSCL   =          8.096E-05 / Pixel scale along slice (deg)
SLSCL   =         0.00018859 / Pixel scale perp. to slices (deg)
```

Metainformation

```
NAXIS   =                    3
NAXIS1  =                   24
NAXIS2  =                   63
NAXIS3  =                 1901

OBJECT  = 'NGC5846-UDG1'       / Object name
OBSERVER= 'Various '           / Observer name
INSTRUME= 'KCWI    '           / Instrument
CAMERA  = 'BLUE    '           / Camera (blue,red,fpc)
IMTYPE  = 'OBJECT  '           / Image type
GROUPID = '2019-03-31-52'      / Group ID

CURRINST= 'KCWI    '           / DCS Instrument
TARGNAME= 'NGC5846-UDG1'       / DCS Target name
PONAME  = 'IFU     '           / DCS Point origin name
RA      = '15:05:20.31'        / DCS RA
DEC     = '+01:48:49.0'        / DCS Dec
TARGRA  = '15:05:20.46'        / DCS Target RA
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```

```
WAVALL0 =                 4861 / Low inclusive wavelength
WAVALL1 =                 5336 / High inclusive wavelength
WAVGOOD0=    4859.751032916362 / Low good wavelength
WAVGOOD1=    5337.463081480892 / High good wavelength
WAVMID  =    5098.594534348915 / middle wavelength
```

```
IFUPA   =                60.02 / IFU position angle (degrees)
IFUROFF =                  0.0 / IFU-SKYPA offset (degrees)
WCSDIM  =                    3 / number of dimensions in WCS
WCSNAME = 'KCWI    '
RADESYS = 'FK5     '
CTYPE1  = 'RA---TAN'
CTYPE2  = 'DEC--TAN'
CTYPE3  = 'AWAV    '           / Air Wavelengths
CUNIT1  = 'deg     '           / RA units
CUNIT2  = 'deg     '           / DEC units
CUNIT3  = 'Angstrom'           / Wavelength units
CNAME1  = 'KCWI RA '           / RA name
CNAME2  = 'KCWI DEC'           / DEC name
CNAME3  = 'KCWI Wavelength'    / Wavelength name
CRVAL1  =           226.334625 / RA zeropoint
CRVAL2  =  1.8136111111111111 / DEC zeropoint
CRVAL3  =              4808.25 / Wavelength zeropoint
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CD1_2   = 7.01275426041717E-05 / RA degrees per row pixel
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CD3_3   =                0.25 / Wavelength Angstroms per pixel
```

```
PXSCL   =          8.096E-05 / Pixel scale along slice (deg)
SLSCL   =        0.00018859 / Pixel scale perp. to slices (deg)
```

Metainformation

```
NAXIS   =                    3
NAXIS1  =                   24
NAXIS2  =                   63
NAXIS3  =                 1901

OBJECT  = 'NGC5846-UDG1'       / Object name
OBSERVER= 'Various '           / Observer name
INSTRUME= 'KCWI    '           / Instrument
CAMERA  = 'BLUE    '           / Camera (blue,red,fpc)
IMTYPE  = 'OBJECT  '           / Image type
GROUPID = '2019-03-31-52'      / Group ID

CURRINST= 'KCWI    '           / DCS Instrument
TARGNAME= 'NGC5846-UDG1'       / DCS Target name
PONAME  = 'IFU     '           / DCS Point origin name
RA      = '15:05:20.31'        / DCS RA
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WAVGOOD0=    4859.751032916362 / Low good wavelength
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WAVMID  =    5098.594534348915 / middle wavelength
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IFUPA   =                60.02 / IFU position angle (degrees)
IFUROFF =                  0.0 / IFU-SKYPA offset (degrees)
WCSDIM  =                    3 / number of dimensions in WCS
WCSNAME = 'KCWI    '
RADESYS = 'FK5     '
CTYPE1  = 'RA---TAN'
CTYPE2  = 'DEC--TAN'
CTYPE3  = 'AWAV    '           / Air Wavelengths
CUNIT1  = 'deg     '           / RA units
CUNIT2  = 'deg     '           / DEC units
CUNIT3  = 'Angstrom'           / Wavelength units
CNAME1  = 'KCWI RA '           / RA name
CNAME2  = 'KCWI DEC'           / DEC name
CNAME3  = 'KCWI Wavelength'    / Wavelength name
CRVAL1  =           226.334625 / RA zeropoint
CRVAL2  =  1.8136111111111111 / DEC zeropoint
CRVAL3  =              4808.25 / Wavelength zeropoint
CRPIX1  =                 14.5 / RA reference pixel
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CRPIX3  =               -210.0 / Wavelength reference pixel
CD1_1   = -9.4237983519361E-05 / RA degrees per column pixel
CD2_1   = 0.000163356636113151 / DEC degrees per column pixel
CD1_2   = 7.012754260417 17E-05 / RA degrees per row pixel
CD2_2   = 4.045552333489 30E-05 / DEC degrees per row pixel
CD3_3   =                 0.25 / Wavelength Angstroms per pixel
```
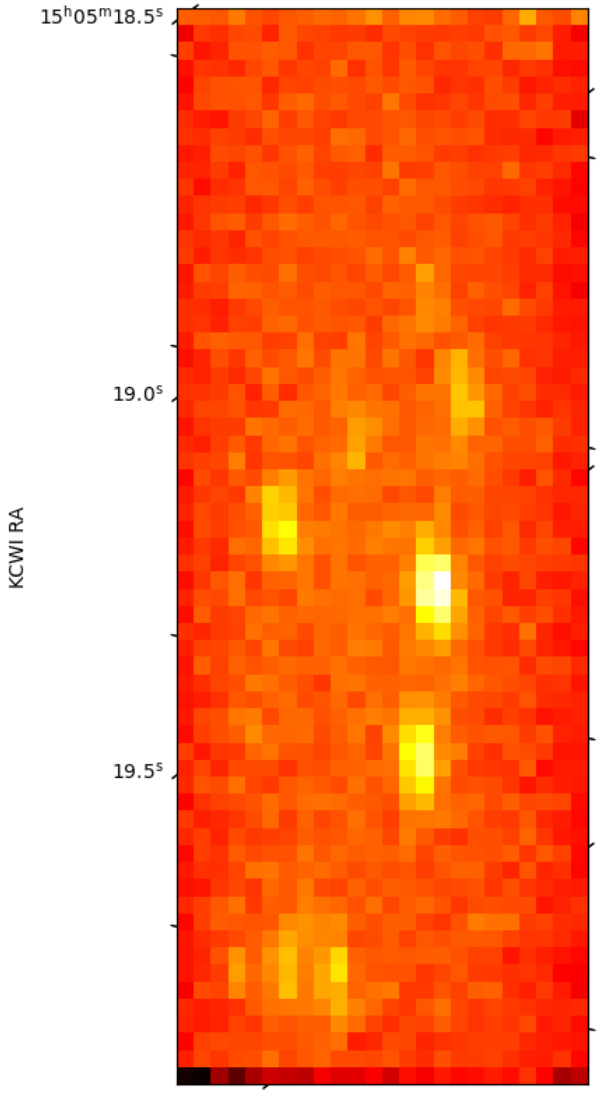
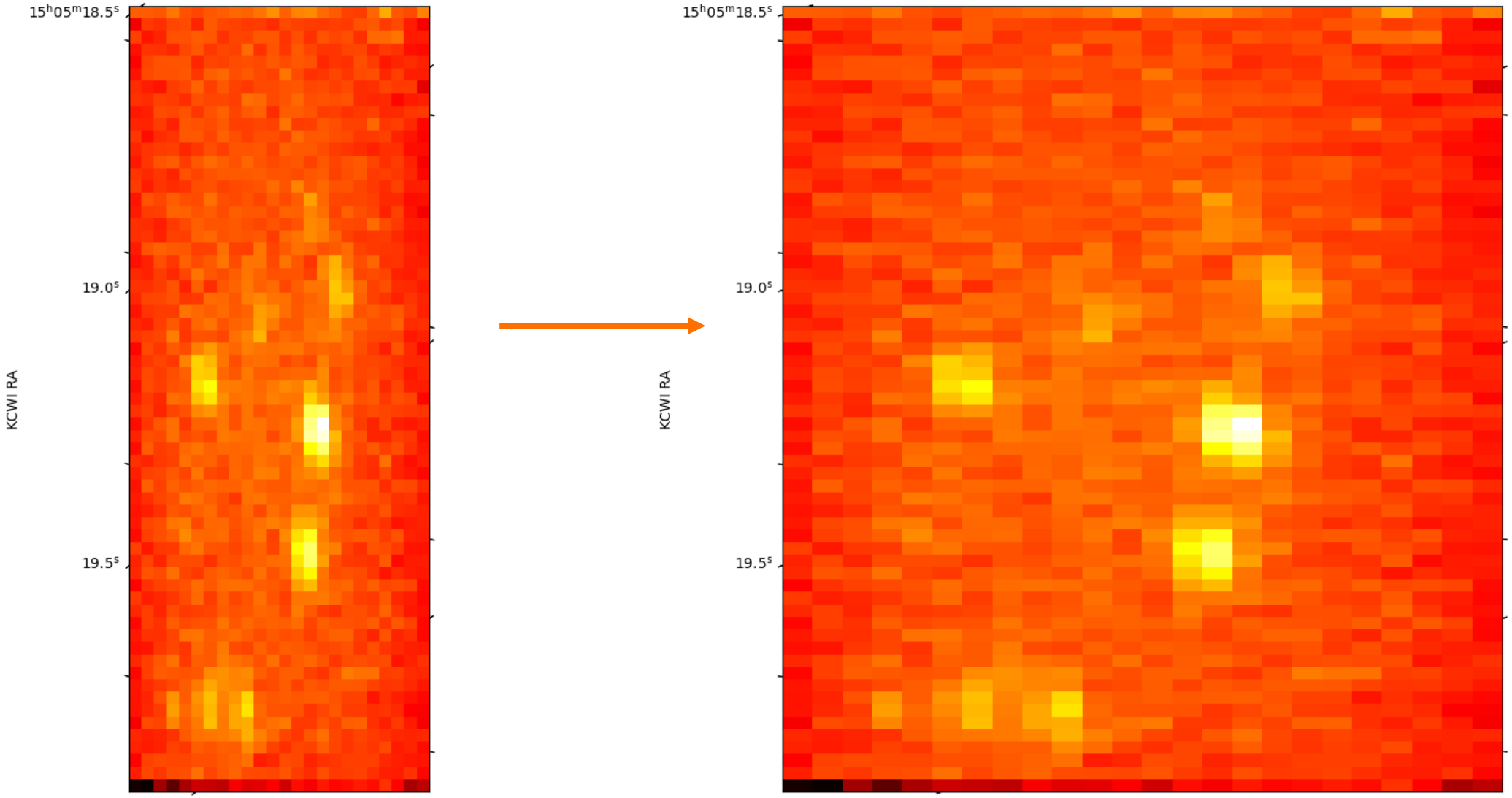

```
PXSCL   =             8.096E-05 / Pixel scale along slice (deg)
SLSCL   =           0.00018859 / Pixel scale perp. to slices (deg)
```

Pixel Shape

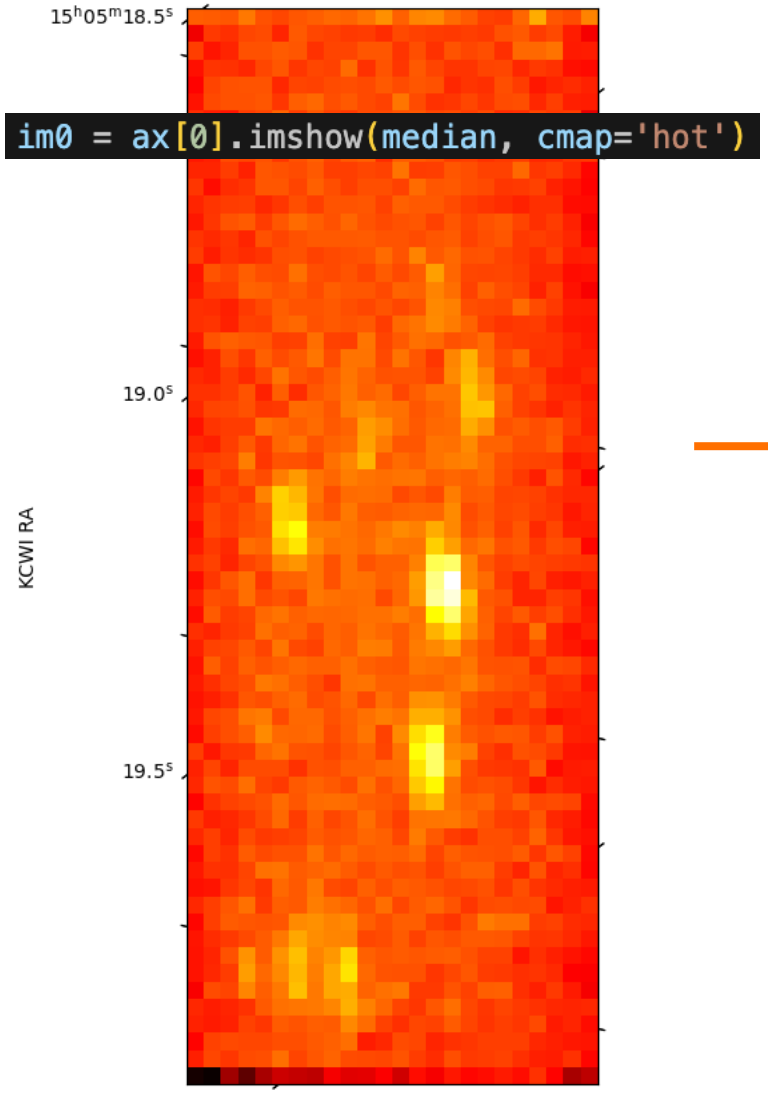


Pixel Shape

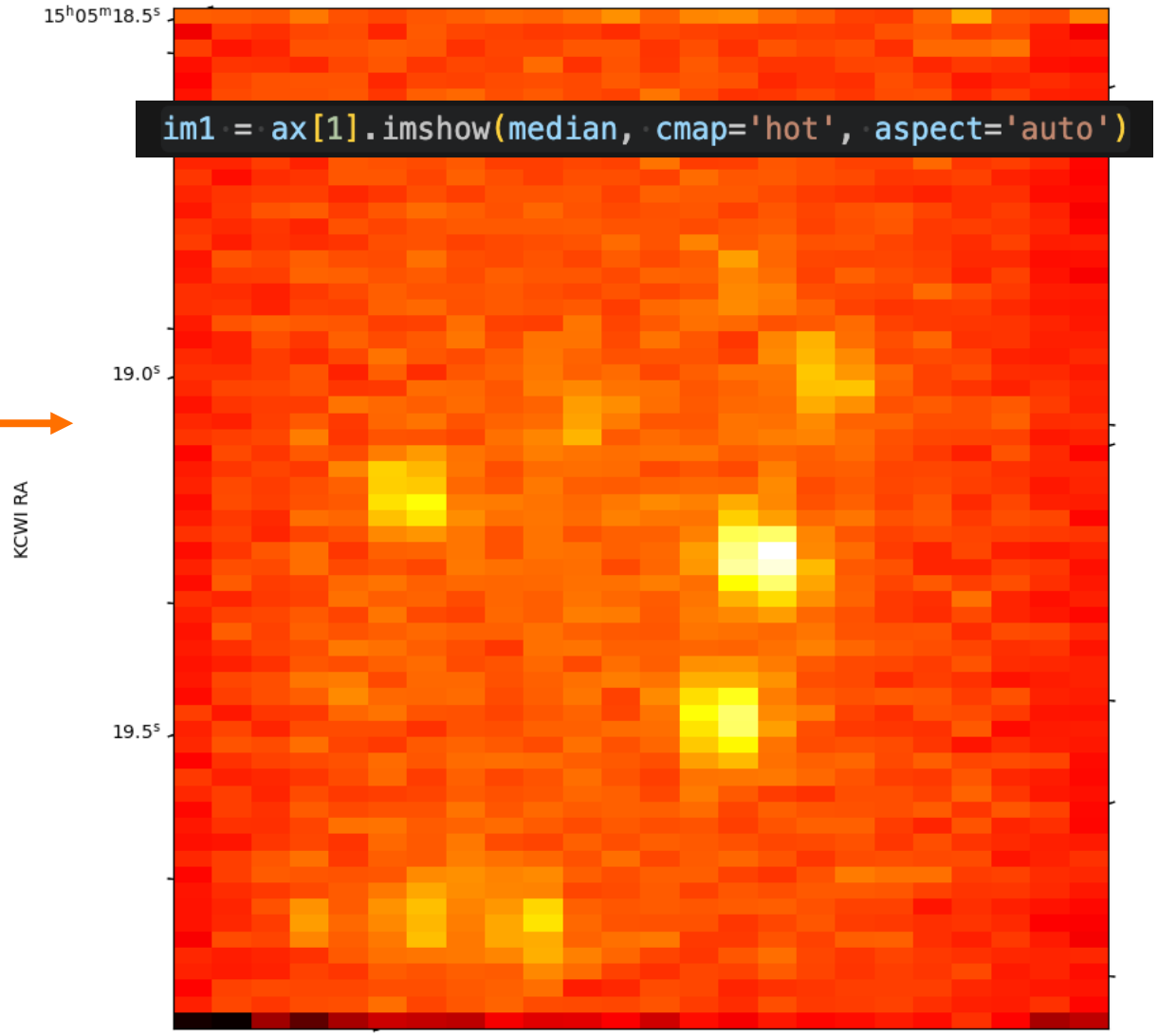


Pixel Shape

```
im0 = ax[0].imshow(median, cmap='hot')
```



```
im1 = ax[1].imshow(median, cmap='hot', aspect='auto')
```



MontagePy

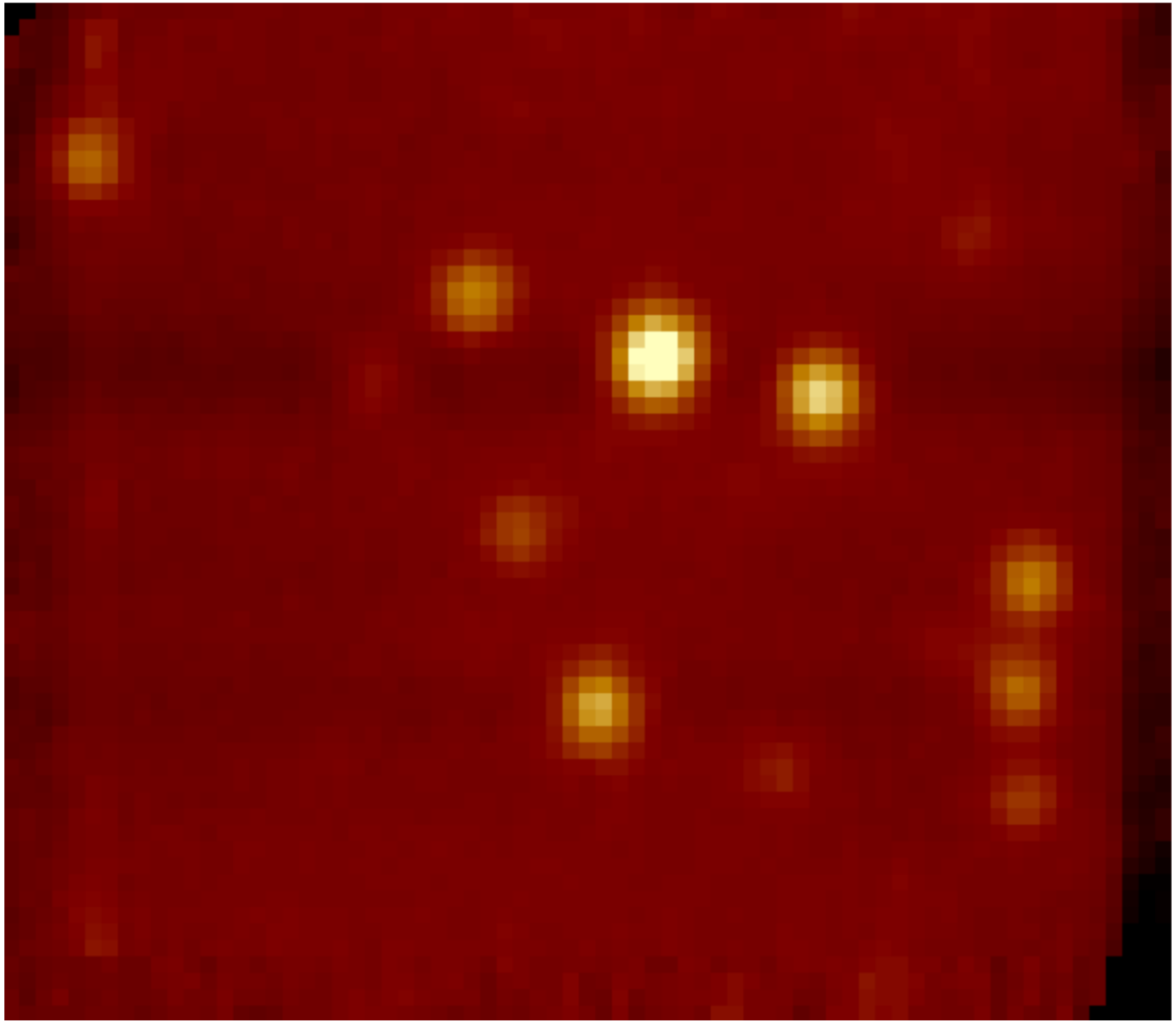
- Rebins cube shaped data
- Steps to take before applying
  - Cut overhang pixel and bad wavelengths
  - Ensure there is no instrument specific artefacts in your cubes (i.e. correct KCWI gradient)
  - Ensure central wavelengths & coordinates of your cubes match & are correct (i.e. correct KCWI cubes for offset RA)
- Good idea to clear everything that is not needed out of the directories you work with

MontagePy Intermission

(+ some complaining about KCWI peculiarities)

MontagePy Result

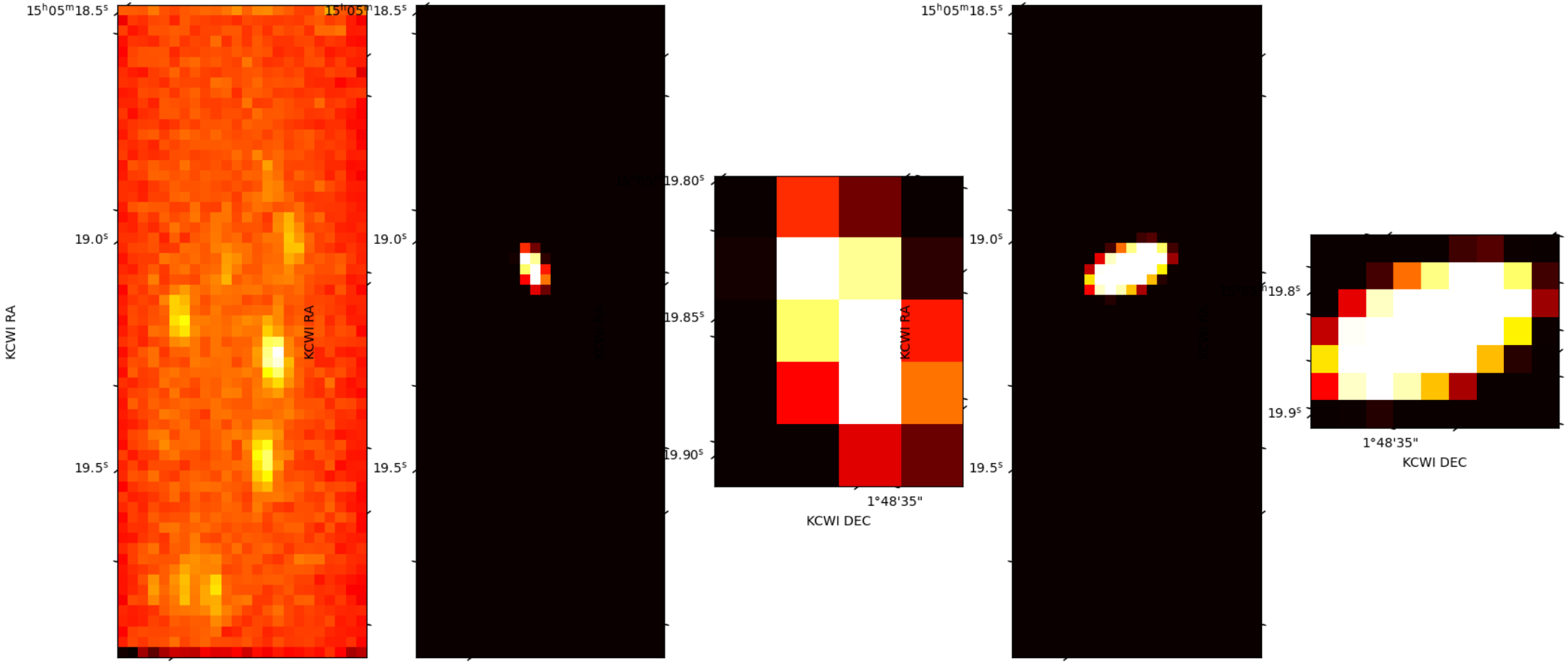
- Pixels are actually square
- Flux conserved



Extracting Spectra (+Packages)

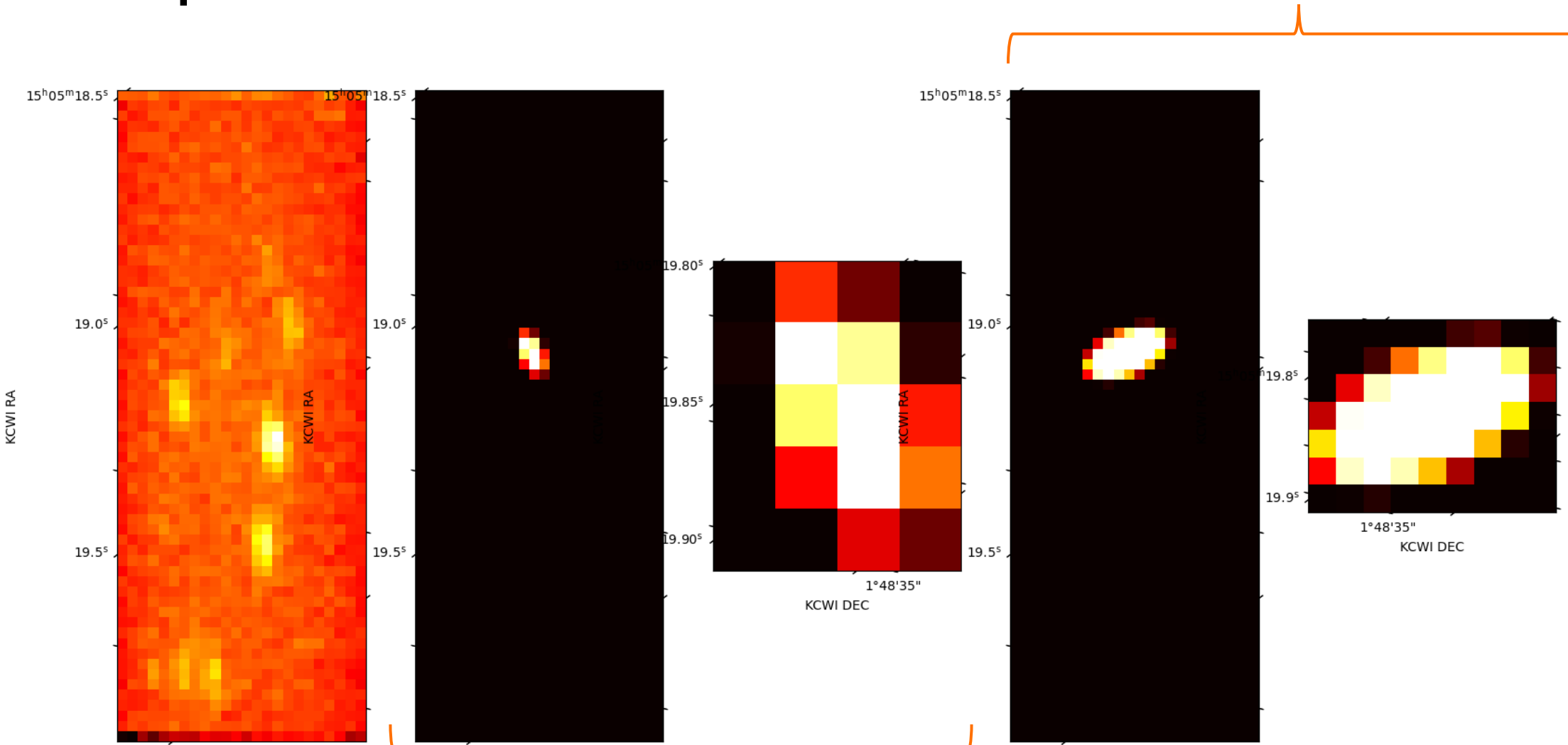
- Create a regions file with regions you want spectra of (this can be easier to do in ds9 than automatically)
- Packages needed
  - from astropy.wcs import WCS
  - from astropy.coordinates import SkyCoord
  - from regions import Regions
  - from photutils.aperture import SkyElliptical Aperture

On Apertures



On Apertures

```
# SkyElliptical aperture takes the size after rotation as input
aper = SkyEllipticalAperture(positions, 1*u.arcsec, 2*u.arcsec, theta=h1['IFUPA']*u.deg)
```




```
# EllipseSkyRegion takes the size before rotation as input
ell_reg = EllipseSkyRegion(center=positions[0], width=1*u.arcsec, height=2*u.arcsec, angle=h1['IFUPA']*u.deg)
```

Extracting Spectra (+Packages)

- Read masks from regions

‘exact’ allows for fractional pixels

```
aper = SkyEllipticalAperture(region.center, region.width, region.height, theta=region.angle)
aper_pix = aper.to_pixel(wcs=self.wcs.dropaxis(dropax=2))
aper_mask = aper_pix.to_mask(method='exact')
masks.append(aper_mask)
```

- Weigh cubes by mask values

```
# initialise arrays for mask-weighted cubes
mask_weighted_data = np.zeros(shape=self.data_cube_data.shape)
mask_weighted_var = np.zeros(shape=self.var_cube_data.shape)

# get mask images
mask_im = mask.to_image(shape=(self.data_cube_header['NAXIS2'], self.data_cube_header['NAXIS1']))
sky_mask_im = sky_mask.to_image(shape=(self.data_cube_header['NAXIS2'], self.data_cube_header['NAXIS1']))

for j in range(self.data_cube_header['NAXIS3']):
    data_spec_med[j] = np.median(mask.get_values(self.data_cube_data[j,:,:]))
    data_spec_sum[j] = np.sum(mask.get_values(self.data_cube_data[j,:,:]))
    mask_weighted_data[j,:,:] *= mask_im

    var_spec_med[j] = np.median(mask.get_values(self.var_cube_data[j,:,:]))
    var_spec_sum[j] = np.sum(mask.get_values(self.var_cube_data[j,:,:]))
    mask_weighted_var[j,:,:] *= mask_im
```

‘median’ combining vs ‘sum’ combining: median better for spikes on singular pixels