Roman Space Telescope Coronagraph Mueller Matrix

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CGI linear polarization fraction measurements of a target of interest - whether an off-axis point source companion or individual spatial resolution elements within an extended source-, will be plagued by different spurious effects that need to be calibrated or minimized by design.

Instrument polarization effects are described by the end-to-end optical system Mueller Matrix (MM), as shown in Figure 1. The Mueller matrix describes how the overall optical system turns unpolarized light into polarized light, and modifies the source linear polarization fraction and its orientation. Assuming that the target circular polarization fraction is negligible (Vsky=0, a valid assumption for the targets considered), and given that the Roman Coronagraph only measures the linear polarization fraction, 9 MM coefficients must be determined in order to convert an observed Stokes vector into an estimate of the source true Stokes Vector and its linear polarization fraction.

Figure 1: Instrumental effects on the source intrinsic polarization and Stokes vector are described by the Mueller Matrix transform. In the case of the Roman Coronagraph, we only measure the I_{obs}, Q_{obs} and U_{obs} components, and the source circular polarization V_{sky} is assumed to be negligible.

End-to-end optical modeling was conducted by the Roman Coronagraph project team, and resulted in the following pupil averaged **Mueller Matrices** computed at 21 wavelengths ranging from 450 nm to 950 nm by increments of 25 nm. It is assumed that the Mueller matrix is field independent.

AFTA_to_DI_Sep242018.len
  Position   1 , wavelength =   450.0 NM

Pupil averaged Mueller matrix for the field 0.000 0.000
        0.37940   0.00530   0.00000   0.00000
       -0.00531   -0.37860   -0.00001   -0.00004
        0.00000   -0.00003   0.34429   0.15764
        0.00000   0.00000   0.15779   -0.34354

AFTA_to_DI_Sep242018.len
  Position   1 , wavelength =   475.0 NM

Pupil averaged Mueller matrix for the field 0.000 0.000
        0.50486   0.00627   0.00000   0.00000
       -0.00628   -0.50430   -0.00001   -0.00002
        0.00000   -0.00002   0.48155   0.15007
        0.00000   0.00000   0.15015   -0.48101

AFTA_to_DI_Sep242018.len
  Position   1 , wavelength =   500.0 NM

Pupil averaged Mueller matrix for the field 0.000 0.000
        0.58203   0.00653   0.00000   0.00000
       -0.00654   -0.58172   0.00000   0.00000
        0.00000   -0.00001   0.57148   0.10904
        0.00000   0.00000   0.10907   -0.57116

AFTA_to_DI_Sep242018.len
  Position   1 , wavelength =   525.0 NM

Pupil averaged Mueller matrix for the field 0.000 0.000
        0.62888   0.00652   0.00000   0.00000
       -0.00652   -0.62873   0.00000   0.00000
        0.00000   0.00000   0.62630   0.05527
        0.00000   0.00000   0.05528   -0.62615

AFTA_to_DI_Sep242018.len
  Position   1 , wavelength =   550.0 NM

Pupil averaged Mueller matrix for the field 0.000 0.000
        0.65761   0.00640   0.00000   0.00000
       -0.00640   -0.65756   0.00001   0.00001
        0.00000   0.00000   0.65747   -0.00094
        0.00000   0.00000   -0.00094   -0.65741

AFTA_to_DI_Sep242018.len
  Position 1 , wavelength = 575.0 NM

Pupil averaged Mueller matrix for the field 0.000 0.000
        0.67450   0.00623   0.00000   0.00000
       -0.00623   -0.67448   0.00001   0.00001
        0.00000   0.00000   0.67213   -0.05384
        0.00000   0.00000   -0.05384   -0.67211

AFTA_to_DI_Sep242018.len
  Position 1 , wavelength = 600.0 NM

Pupil averaged Mueller matrix for the field 0.000 0.000
        0.68442   0.00603   0.00000   0.00000
       -0.00603   -0.68439   0.00000   0.00002
        0.00000   0.00000   0.67636   -0.10254
        0.00000   0.00000   -0.10255   -0.67632

AFTA_to_DI_Sep242018.len
  Position 1 , wavelength = 625.0 NM

Pupil averaged Mueller matrix for the field 0.000 0.000
        0.68932   0.00580   0.00000   -0.00001
       -0.00580   -0.68923   0.00000   0.00002
        0.00000   0.00000   0.67316   -0.14607
        0.00000   0.00000   -0.14607   -0.67307

AFTA_to_DI_Sep242018.len
  Position 1 , wavelength = 650.0 NM

Pupil averaged Mueller matrix for the field 0.000 0.000
        0.69043   0.00554   0.00000   -0.00001
       -0.00554   -0.69028   -0.00001   0.00003
        0.00000   -0.00001   0.66482   -0.18387
        0.00000   0.00000   -0.18387   -0.66467

AFTA_to_DI_Sep242018.len
  Position 1 , wavelength = 675.0 NM

Pupil averaged Mueller matrix for the field 0.000 0.000
        0.68866   0.00524   0.00000   -0.00001
       -0.00524   -0.68842   -0.00001   0.00003
        0.00000   -0.00001   0.65327   -0.21534
        0.00000   0.00000   -0.21535   -0.65303

AFTA_to_DI_Sep242018.len
  Position 1 , wavelength = 700.0 NM

Pupil averaged Mueller matrix for the field 0.000 0.000
```
    0.68453    0.00492    0.00000   -0.00001
   -0.00492   -0.68421   -0.00002    0.00004
    0.00000   -0.00001    0.63981   -0.24068
    0.00000    0.00000   -0.24069   -0.63949
```

AFTA_to_DI_Sep242018.len
  Position 1 , wavelength = 725.0 NM

Pupil averaged Mueller matrix for the field 0.000 0.000
```
    0.67845    0.00455    0.00000   -0.00001
   -0.00455   -0.67804   -0.00002    0.00005
    0.00000   -0.00002    0.62560   -0.25979
    0.00000    0.00000   -0.25980   -0.62519
```

AFTA_to_DI_Sep242018.len
  Position 1 , wavelength = 750.0 NM

Pupil averaged Mueller matrix for the field 0.000 0.000
```
    0.67071    0.00416    0.00000   -0.00001
   -0.00416   -0.67023   -0.00002    0.00006
    0.00000   -0.00002    0.61155   -0.27266
    0.00000    0.00000   -0.27269   -0.61108
```

AFTA_to_DI_Sep242018.len
  Position 1 , wavelength = 775.0 NM

Pupil averaged Mueller matrix for the field 0.000 0.000
```
    0.66133    0.00374    0.00000   -0.00001
   -0.00374   -0.66079   -0.00002    0.00006
    0.00000   -0.00003    0.59823   -0.27921
    0.00000    0.00000   -0.27924   -0.59770
```

AFTA_to_DI_Sep242018.len
  Position 1 , wavelength = 800.0 NM

Pupil averaged Mueller matrix for the field 0.000 0.000
```
    0.65085    0.00329    0.00000   -0.00001
   -0.00330   -0.65026   -0.00002    0.00006
    0.00000   -0.00003    0.58635   -0.27987
    0.00000    0.00000   -0.27991   -0.58578
```

AFTA_to_DI_Sep242018.len
  Position 1 , wavelength = 825.0 NM

Pupil averaged Mueller matrix for the field 0.000 0.000
```
     0.63956     0.00284     0.00000    -0.00001
    -0.00284    -0.63895    -0.00002     0.00006
     0.00000    -0.00003     0.57627    -0.27492
     0.00000     0.00000    -0.27496    -0.57568
```

AFTA_to_DI_Sep242018.len
  Position 1 , wavelength = 850.0 NM

Pupil averaged Mueller matrix for the field 0.000 0.000
```
     0.62776     0.00238     0.00000    -0.00001
    -0.00238    -0.62715    -0.00002     0.00006
     0.00000    -0.00003     0.56815    -0.26471
     0.00000     0.00000    -0.26476    -0.56756
```

AFTA_to_DI_Sep242018.len
  Position 1 , wavelength = 875.0 NM

Pupil averaged Mueller matrix for the field 0.000 0.000
```
     0.61552     0.00193     0.00000    -0.00001
    -0.00193    -0.61493    -0.00002     0.00006
     0.00000    -0.00003     0.56174    -0.24957
     0.00000     0.00000    -0.24962    -0.56116
```

AFTA_to_DI_Sep242018.len
  Position 1 , wavelength = 900.0 NM

Pupil averaged Mueller matrix for the field 0.000 0.000
```
     0.60343     0.00150     0.00000    -0.00001
    -0.00151    -0.60288    -0.00002     0.00005
     0.00000    -0.00003     0.55706    -0.23017
     0.00000     0.00000    -0.23022    -0.55652
```

AFTA_to_DI_Sep242018.len
  Position 1 , wavelength = 925.0 NM

Pupil averaged Mueller matrix for the field 0.000 0.000
```
     0.59182     0.00111     0.00000    -0.00001
    -0.00112    -0.59132    -0.00002     0.00004
     0.00000    -0.00003     0.55380    -0.20715
     0.00000     0.00000    -0.20719    -0.55332
```

AFTA_to_DI_Sep242018.len
  Position   1 , wavelength =   950.0 NM

Pupil averaged Mueller matrix for the field 0.000 0.000
     0.58101   0.00077   0.00000   0.00000
    -0.00077   -0.58057   -0.00001   0.00003
     0.00000   -0.00002   0.55160   -0.18123
     0.00000   0.00000   -0.18127   -0.55117