MaNGA Kinematics Data Products

We present the kinematic data products created through the analysis presented in Brownson2021. Please direct any queries to the authors, Simcha Brownson (sbb33@cam.ac.uk) and Asa Bluck (ab2531@cam.ac.uk).

The following three data products are provided:

a) KinematicModelParameters.fits

This FITs table lists the best estimate and associated error of the seven inclined rotating disc model parameters for 1461 DR15 MaNGA galaxies whose moment-1 kinematics are consistent with our inclined rotating disc model. The errors are the model fitting errors as output by LMFIT. We note that these errors do not fully account for the uncertainties on the input data, and moreover that they are dependent on the assumed kinematic model - i.e., an inclined rotating disc model and tanh(r/r_c) rotation curve in this case. For context, we performed a full error analysis for V_max and found that the typical error is 3%.

The FITs table contains the following columns:

- PlateIFU [Type:String] – The unique PLATEID-ifuDesign.
- Moment-0 Map [Type:String] – The moment-0 map adopted to fit the moment-1 kinematics, both during the convolution with the PSF and Voronoi binning. The moment-0 map takes one of two forms: a Sersic model to SDSS photometry from the NSA catalogue, or the g-band flux map from the data analysis pipeline (DAP).
- xo [Type:String, Units:arcsec] – The offset of the kinematic centre relative to the photometric centre in the R.A. direction.
- Error xo [Type:String, Units:arcsec] – The error on the offset of the kinematic centre relative to the photometric centre in the R.A. direction.
- yo [Type:String, Units:arcsec] – The offset of the kinematic centre relative to the photometric centre in the Dec. direction.
- Error yo [Type:String, Units:arcsec] – The error on the offset of the kinematic centre relative to the photometric centre in the Dec. direction.
- V_max [Type:float, Units:km/s] – The maximum rotational velocity.
- Error V_max [Type:float, Units:km/s] – The error on maximum rotational velocity.
- r_c [Type:float, Units:arcsec] – The kinematic lengthscale.
- Error r_c [Type:float, Units:arcsec] – The error on the kinematic lengthscale.
- PA [Type:float, Units:radian] – The kinematic position angle.
- Error PA [Type:float, Units:radian] – The error on the kinematic position angle.
- inc [Type:float, Units:radian] – The kinematic inclination.
- Error inc [Type:float, Units:radian] – The error on the kinematic inclination.
- V_sys [Type:float, Units:km/s] – The systemic velocity.
- Error V_sys [Type:float, Units:km/s] – The error on the systemic velocity.

b) KinematicParameters.fits

This FITs table lists the seven derived kinematic parameters reported in Brownson2021 and their associated errors. We also include estimates of the global stellar mass and star formation rate from Blanton2011 and Brinchmann2004, respectively. We report two estimates of each kinematic parameter, one found using the inclined rotating disc model and the other found using the alternative simple method discussed in Brownson2021. The uncertainties on the kinematic parameters are found by propagating the uncertainties on the raw data – i.e., the line-of-sight stellar velocity and stellar velocity dispersion maps from the DAP. We also include an estimate of 0.125Re when calculating the dynamical mass, since this parameter is strongly sensitive to the radius of the annulus.

We note that the table includes 2072 galaxies, which is larger than the 1862 analysed in Brownson2021. This is because some of the 2072 galaxies listed here do not have an associate global star formation rate estimate from Brinchmann2004. They thus were not considered in our study of galaxy quenching. The star formation rate for these galaxies is set to -999 to indicate that they lack an estimate of star formation rate.

The FITs table contains the following columns:

- PlateIFU [Type:String] – The unique PLATEID-ifuDesign.
- Method [Type:String] – The optimal method for estimating the kinematics for each galaxy, and indeed the method adopted in Brownson2021. This corresponds to the 'inclined rotating disc model' when the fit is good and the 'simple method' otherwise. We set the inclined rotating disc model kinematic parameters to -999 when the model is inconsistent with the observed kinematics.
- Global Stellar Mass [Type:float, Units:Msun] – The global stellar mass, taken from Blanton2011. The stellar mass is presented in linear units.
- Global SFR [Type:float, Units:Msun/year] – The global star formation rate, taken form Brinchmann2004. The star formation rate is presented in linear units.
- <V> (Inclined Rotating Disc Model) [Type:float, Units:km/s] – The mass-weighted average circular velocity within 1Re, calculated using the inclined rotating disc method.
- Error <V> (Inclined Rotating Disc Model) [Type:float, Units:km/s] – The error on the mass-weighted average circular velocity within 1Re, calculated using the inclined rotating disc method.
- <Sigma> (Inclined Rotating Disc Model) [Type:float, Units:km/s] – The mass-weighted average velocity dispersion within 1Re, calculated using the inclined rotating disc method. Note, this is the total velocity dispersion, rather than line-of-sight.
- Error <Sigma> (Inclined Rotating Disc Model) [Type:float, Units:km/s] – The error on the mass-weighted average velocity dispersion within 1Re, calculated using the inclined rotating disc method.
- <V>/<Sigma> (Inclined Rotating Disc Model) [Type:float, Units:dimensionless] – The ratio of <V> to <Sigma>, calculated using the inclined rotating disc method.
- Error <V>/<Sigma> (Inclined Rotating Disc Model) [Type:float, Units:dimensionless] – The error on the ratio of <V> to <Sigma>, calculated using the inclined rotating disc method.

- <Specific Kinetic Energy> (Inclined Rotating Disc Model) [Type:float, Units:km^2/s^2] – The mass-weighted average specific kinetic energy within 1Re, calculated using the inclined rotating disc method.
- Error <Specific Kinetic Energy> (Inclined Rotating Disc Model) [Type:float, Units:km^2/s^2] – The error on the mass-weighted average specific kinetic energy within 1Re, calculated using the inclined rotating disc method.
- <Specific Angular Momentum> (Inclined Rotating Disc Model) [Type:float, Units:kpckm/s] – The mass-weighted average specific angular momentum within 1Re, calculated using the inclined rotating disc method.
- Error <Specific Angular Momentum> (Inclined Rotating Disc Model) [Type:float, Units:kpckm/s] – The error on the mass-weighted average specific angular momentum within 1Re, calculated using the inclined rotating disc method.
- Dynamical Mass (Inclined Rotating Disc Model) [Type:float, Units:Msun] – The dynamical mass within 1Re, calculated using the inclined rotating disc method. The dynamical mass is presented in linear units.
- Error Dynamical Mass (Inclined Rotating Disc Model) [Type:float, Units:Msun] – The error on the dynamical mass within 1Re, calculated using the inclined rotating disc method.
- Spin Parameter (Inclined Rotating Disc Model) [Type:float, Units:dimensionless] – The dimensionless spin parameter, calculated using the inclined rotating disc method.
- Error Spin Parameter (Inclined Rotating Disc Model) [Type:float, Units:dimensionless] – The error on the dimensionless spin parameter, calculated using the inclined rotating disc method.
- <V> (Simple Method) [Type:float, Units:km/s] – The mass-weighted average circular velocity within 1Re, calculated using the simple method.
- Error <V> (Simple Method) [Type:float, Units:km/s] – The mass-weighted average circular velocity within 1Re, calculated using the simple method.
- <Sigma> (Simple Method) [Type:float, Units:km/s] – The mass-weighted average velocity dispersion within 1Re, calculated using the simple method. Note, this is the total velocity dispersion, rather than line-of-sight.
- Error <Sigma> (Simple Method) [Type:float, Units:km/s] – The error on the mass-weighted average velocity dispersion within 1Re, calculated using the simple method.
- <V>/<Sigma> (Simple Method) [Type:float, Units:dimensionless] – The ratio of <V> to <Sigma>, calculated using the simple method.
- Error <V>/<Sigma> (Simple Method) [Type:float, Units:dimensionless] – The error on the ratio of <V> to <Sigma>, calculated using the simple method.
- <Specific Kinetic Energy> (Simple Method) [Type:float, Units:km^2/s^2] – The mass-weighted average specific kinetic energy within 1Re, calculated using the simple method.
- Error <Specific Kinetic Energy> (Simple Method) [Type:float, Units:km^2/s^2] – The error on the mass-weighted average specific kinetic energy within 1Re, calculated using the simple method.

- <Specific Angular Momentum> (Simple Method) [Type:float, Units:kpckm/s] – The mass-weighted average specific angular momentum within 1Re, calculated using the simple method.
- Error <Specific Angular Momentum> (Simple Method) [Type:float, Units:kpckm/s] – The error on the mass-weighted average specific angular momentum within 1Re, calculated using the simple method.
- Dynamical Mass (Simple Method) [Type:float, Units:Msun] – The dynamical mass within 1Re, calculated using the inclined rotating disc method. The dynamical mass is presented in linear units.
- Error Dynamical Mass (Simple Method) [Type:float, Units:Msun] – The error on dynamical mass within 1Re, calculated using the simple method.
- Spin Parameter (Simple Method) [Type:float, Units:dimensionless] – The dimensionless spin parameter, calculated using the simple method.
- Error Spin Parameter (Simple Method) [Type:float, Units:dimensionless] – The error on the dimensionless spin parameter, calculated using the simple method.

c) <Plate-IFU>MomentMaps.fits

A file of this type is included in Maps.zip for each of the galaxies listed in KinematicModelParameters.fits – i.e., those that are well fit by the inclined rotating disc model.

The primary header lists the object centre (OBJRA, OBJDEC), IFU pointing direction (IFURA, IFUDEC), the central pixel (CRPIX1, CRPIX2), and the angular extent of the pixels (0.5 arcsec).

Each FITs file has three extensions.

i) Moment-0 [Units:dimensionless] – This contains two maps that can be accessed separately as if they are channels within a 3D datacube. The first channel, the data, is the g-band flux map taken from the DAP, and the second channel, the model, is the Sersic model fit to SDSS photometry taken from the NSA catalogue, shown out to 1.5Re from the kinematic centre. Both maps are normalised to a peak value of 1 and are therefore dimensionless. The keyword 'Moment-0UsedForFitting' in the header indicates which of these two fits was used to fit the moment-1 kinematics, and as such it directly corresponds to the Momet-0 Map column in KinematicModelParameters.fits

ii) Moment-1 [Units:km/s] – This contains three maps that can be accessed separately as if they are channels within a 3D datacube. The first channel, the data, is the observed line-of-sight stellar velocity taken from the DAP; the second channel, the observed model, is the PSF-convolved and Voronoi binned best-fitting inclined rotating disc model which can be compared directly with the data to assess the quality of the fit; and the third channel is the PSF-corrected best-fitting inclined rotating disc model presented in spaxels (rather than voxels), shown out to 1.5Re from the kinematic centre. Note, the velocities in the first and second channels are relative to the redshift from the NSA catalogue, whilst the velocities in the third channel are relative to the systemic velocity determined through our kinematic modelling. As in the Moment-0 extension, the keyword 'Moment-0UsedForFitting' in the header indicates the moment-0 map that was used to fit the moment-1 kinematics.

iii) Moment-2 [Units:km/s] – This contains three maps that can be accessed separately as if they are channels within a 3D datacube. The first channel, the data, is the DAP stellar velocity dispersion corrected for the dispersion induced by differential disc rotation; the second channel, the observed model, is a voxel map of the best-fitting 2D Gaussian (with centre and position angle fixed to those of the best-fitting moment-1 model) which can be directly compared with the data to assess the quality of the fit; and in the third channel, the intrinsic model, is the spaxel map of the best-fitting 2D Gaussian, shown out to 1.5Re from the kinematic centre.

In modelling the moment-2 map, we have corrected for the leading beam-smearing effect induced by differential disc rotation, but we have not accounted for the secondary beam-smearing effect which redistributes true (rather that induced) velocity dispersion onto larger spatial scales. However, the kinematic parameters derived in Brownson2021 are calculated on scales much larger than the PSF, and hence we are not concerned by this redistribution.

We note that the moment-2 model presented in the third channel was not used to calculate the kinematic parameters presented in KinematicParameters.fits, which were instead calculated using the data in the first channel. We have checked that the estimates of <Sigma> calculated using both maps are consistent to better than 95 per cent for more than 90 per cent of the galaxies presented in KinematicModelParameters.fits. We flag galaxies for which the two estimates of <Sigma> differ by more than 25 per cent via the keyword 'Trust_Model' in the header. We advise against using the model in the second channel for galaxies with 'Trust_Model' set to 'No'.

See readingmaps.py for a demonstration of loading the maps in Python.