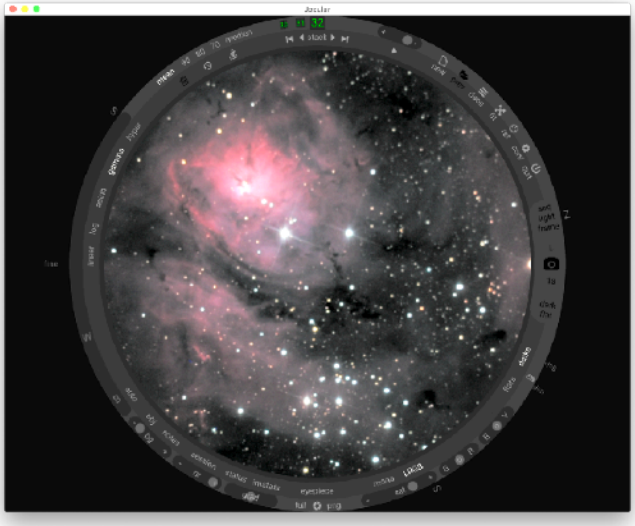
Jocular v0.4.2 Users' Guide

Jocular is an application developed specifically for electronically-enhanced visual astronomy (EEVA) with 4 interlinked uses: (1) live viewing of astronomical objects via a telescope, (2) reloading and processing of previously captured images, (3) observation planning and (4) automatic deep annotation of images.

Jocular's design philosophy is to make observing as distraction-free as possible without sacrificing functionality, and to ensure that no photons are wasted. All decisions except what to point the scope at are reversible during the course of the live observation. Practically everything you need to enjoy a complete live observing session can be found on a single screen.

Please visit https://transpy.eu.pythonanywhere.com/jocular/ for details of installation etc.

Features (new in v0.4 in **bold**)



- tuneable gradient removal
- variable noise reduction
- choice of stretch functions
- automatic blackpoint estimation
- access to the complete stack
- **sub deletion**
- fast reprocessing of the stack
- **save as animated GIF**
- robust alignment & re-alignment
- native capture for the SX Lodestar and the SX electronic filter wheel
- alternatively, monitors directory for incoming FITs
- **debayering of colour sensors**
- **binning on input**
- single-click capture scripts for multiple filters e.g. to support LRGB captures
- fully-automated management of a calibration library
- LAB-based, histogram-free colour adjustments
- **L + narrowband combination**
- image panning, free rotation and zooming
- image inversion and flipping
- automatically-annotated snapshots in various styles and formats
- large and user-extendable object database
- observation planning tools
- observation and sesssion note-taking
- automatic management of observation data e.g. to enable use in other programs
- reloading/processing of previous captures
- **deep annotation via local platesolving**
- user-configurable appearance
- open-source (Python) **now on GitHub** and open data formats (csv, json, ini)
- runs on OSX, Windows & Linux
- **installed using pip**
- **project website: https://transpy.eu.pythonanywhere.com/jocular/**

Known bugs. (1) There is an intermittent bug that occurs every 10 or 15 startups where the tool only responds to double click rather than single click; until this is fixed, the simple solution is to start the program again. (2) Daylight saving is not yet catered for. Please visit the website https://transpy.eu.pythonanywhere.com/jocular/ [note the final slash!] for an up to date list.

Live viewing

Native image capture. These instructions assume that you have a compatible camera in order to use Jocular to capture images directly. If not, see the next section.

First, select one of the six scripts (**frame, light, seq, flat, dark, bias**), then choose an exposure by clicking on the exposure indicator (**1s** here). Optionally, choose a filter by clicking on the filter indicator (**L** here). To start the capture, click on the **camera** symbol. Click again to stop the capture.

The frame script is used for focus, alignment and framing. These images are not saved but simply displayed. The light script is for normal captures through a single filter. If you want to capture through a sequence of filters, choose the seq option. This is useful for LRGB captures. The dark, flat & bias scripts are used to collect calibration subs which also lead to the creation of masters when saved.

Capture via the watched directory

Jocular can also be used by dropping your FITs format images into the watched folder which is created inside your jocular data directory. Simply point your capture software at that directory and Jocular will do the rest; or explore the tool by dropping FITs in manually.

Jocular only handles mono images internally so if you have a colour sensor, you need to set things up so that Jocular splits your image into RGB channels automatically. Go to the Watcher panel of the configuration screen to choose the Bayer pattern for your sensor. Each sub will appear as three subs within the tool. Jocular also keeps a copy of your original colour sub in a subdirectory of the image directory called ‘originals’.

Jocular can also bin your images on input. This is set up on the Watcher config panel, and can be combined with debayering (images are debayered then binned).

***Note**: If you are using a sensor with more than 2 million pixels, I strongly recommend that you apply binning, either in your capture program or in Jocular, as the live viewing experience is much smoother with small sensor pixel counts.*

If you bin in Jocular, new FITs are created and your original unbinned image is saved in originals, as for debayering. This means that subsequent reloads are much faster.

Image stacking. Regardless of whether you are using Jocular or another program to capture your images, as images appear you will see a numeric indication of the individual subs at the top of the screen. The figure shows that we are viewing sub number 9. By using the arrows you can step through the entire stack of subs. If you find a sub that you want to temporarily remove from the stack, simply click on its number when it appears in the central window. You can reselect it at any point by clicking again. To delete a sub from the stack click the bin icon to the right of the sub number scroller.

Subs can be animated using the **play arrow**. The slider controls the **speed**.

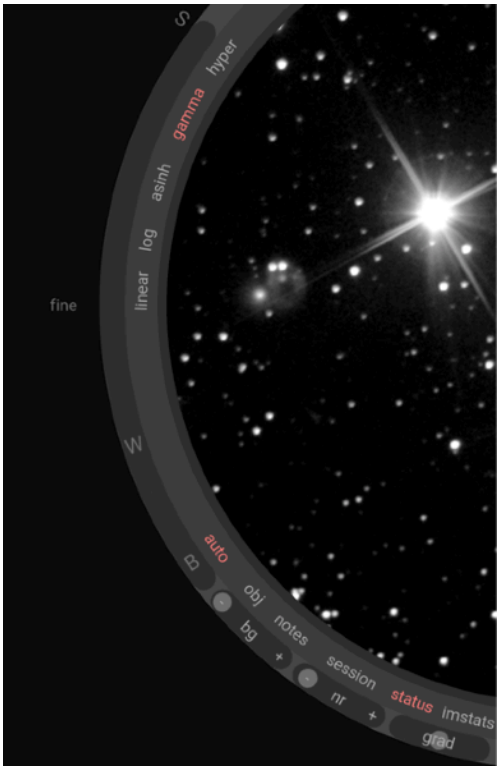
Most of the time we want to view the stack rather than individual subs. This is done by clicking on the word **sub**, which changes to **stack**. This shows the stack *up to the currently-displayed sub*. Normally we would be looking at the latest stack, achieved by clicking on the rightmost arrow, but it is useful to be able to see the stack at any point.

Sometimes it is necessary to clear the stack and start again. This is done by clicking the other **bin** symbol, the one appearing under the word 'mean'. We can also change the way the subs are combined to form the stack. Options are **mean** and **median**, as well as 3 outlier-removal techniques (**90, 80, 70**) that differ in the percentiles at which outliers are removed.

The **redo** icon will reprocess the entire stack. This is usually quite quick. It is useful when we make some change to a property and wish to see the effect 'live'. For instance, suppose we elected to use flats but find that they appear to degrade the image. We could simply deselect flats and click redo.

The overflowing intray **stack of paper** icon also reprocesses the stack, but in addition it shuffles the order of the subs first. This can often solve alignment issues. It is especially useful when dealing with mixtures of luminance and RGB or narrowband subs since the star extraction threshold is set based on the initial sub, and if that is luminance the value chosen may not be appropriate for the less-transmissive RGB or narrowband filters. Shuffling the subs actually also reorders them in order of increasing transmissivity to increase the chance of successful alignment. Shuffling is quite fast, so do keep shuffling until you manage to solve your alignment problem, assuming it is solvable!

Image manipulation. Adjusting the luminosity elements of the image (see later for colour) is done using controls on the left hand side of the eyepiece. Jocular provides the conventional black and white points (**B** and **W**) but most manipulation involves selecting one of the 5 stretch functions (linear, log, etc) and modifying the degree of stretch slider, **S**. When S is nearer the base of the screen the degree of stretch is low, and increases as you move the slider toward the top of its range. The **hyper** stretch function provides the most vigorous stretch. The **gamma** stretch is a corrected gamma function (with a linearised-lower end).



The auto toggle, when set, estimates the background level automatically. *I recommend you leave this on most of the time*. The black point can then be ignored, and fine adjustments to the background level made using the **bg** slider. Alternatively, with auto off, the control labelled **fine** can be used to make small adjustments to the black point.

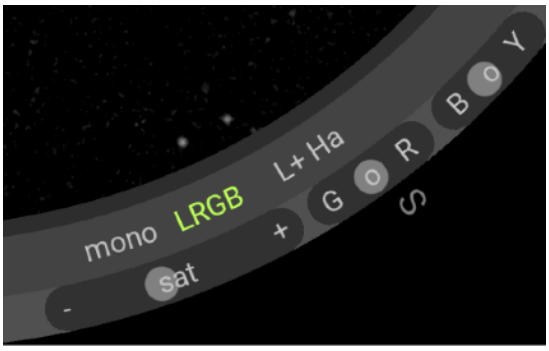
Light-touch noise reduction is performed by moving the slider labelled **nr**. At the upper end it is off. Gradient removal is achieved by moving the **grad** slider. In the middle of the range it performs optimal gradient removal (based on the estimated gradient), but you may wish to modify this based on actually seeing how the gradient reacts as you change the slider.

Moving, zooming and rotating the image. The image can be panned with the mouse by clicking and dragging in the central part of the view. To rotate the image about its current centre, click and drag in the outer part of the view. The slider labelled **Z** is used to zoom in and out. Note that more permanent up-down and left-right image flipping is set using the configuration screen, accessed with the cog icon (**conf**).

The image can be **inverted** (photographic negative style) by double-clicking in the view area.

Saving snapshots. Clicking the iris icon at the base of the eyepiece saves an image to your snapshots directory (a subdirectory of your Jocular data directory). The style (eyepiece or landscape), amount of annotation (full, name only or none) and format (png, jpg, fits) are chosen by clicking through the options next to the iris symbol. The eyepiece style saves as viewed (ie with the current rotation and zoom).

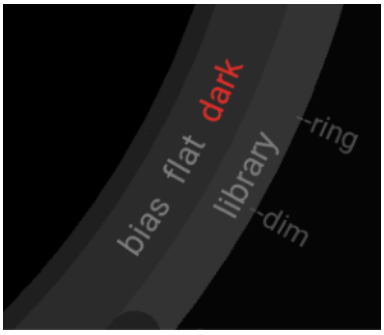
Colour. Colour is available as soon as there is at least one sub in each of the L, R, G and B filters (RGB without L is not supported yet). Select LRGB to view the stack colour. Sliders control saturation (**sat**), colour stretch (**S**), green-red and blue-yellow colour balance. Configuration options allow you to modify colour binning (default: 2x2) and automatic colour gradient subtraction (default: on).



Colour is represented internally in LAB space, so use the luminosity controls to modify the luminosity component as you would normally.

If you have L and one of Ha, OIII or SII, the narrowband stack can be treated as a separate layer by selecting the L+ icon, then selecting the narrowband channel by clicking the text next to to (showing Ha in the image above). The saturation slider controls the blending while the colour stretch S applies to the narrowband channel.

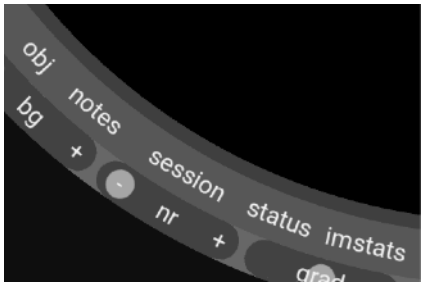
Calibration. To apply calibration to the image, simply click flats, darks and/or bias (bias frames will be applied automatically if you use flats, but it is sometimes interesting to see the effect of bias alone). Jocular will look for appropriate calibration frames in your calibration library (which can be viewed by clicking **library**) and apply them if available. If you have collected master-bias etc in an external program, you can drop the FITs format master in the watched directory and it will be assimilated by Jocular and become available in the library. Names of masters must start with *masterflat*, *masterbias* or *masterdark*. The topic of calibration will be covered elsewhere as there are many options.



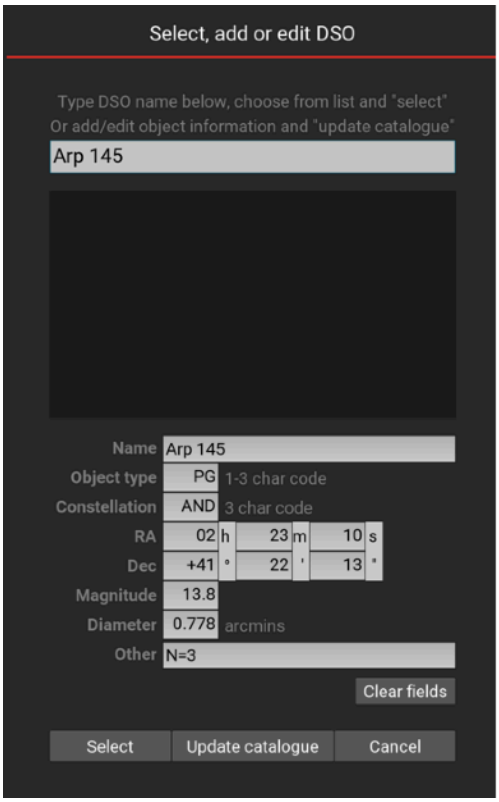
Other controls. The brightness of the controls (but not the image) can be adjusted using the **dim** slider, while the transparency of the ring is adjustable using the **ring** slider. A reticle can be toggled using the **ret** icon. This is essential for alignment and useful at other times. The **fit** icon undoes any rotation you have performed and fits the image to the size of the Jocular screen.

Finishing an observation and starting a new one. Click the **save** icon to save your current observation and start a new one. Jocular automatically saves all incoming FITs files and organises them into a separate directory so that they can be reloaded or so that you can process them with other programs. Jocular also saves metadata describing the observation into a (human-readable) json format file within the same directory.

Additional information panels. Jocular has five additional panels of information, some of it editable, that can be displayed, or not, using the toggle buttons **obj, notes, session, status** and **imstats**.



The obj panel displays information about the DSO. It is initially empty but by clicking on the DSO Name field a popup will appear into which you can type the name of the object. By selecting one of the options that appear below, the object details are filled in. Choosing **select** then places that information on the main display. Object type codes (eg OC, GX, PN) allow disambiguation in cases where the rest of the name refers to more than one object.



If the object isn't in the database, then by filling in the lower fields and clicking **update catalogue**, it gets added to a user catalogue and becomes part of the database. For objects that are in the database but have erroneous or missing information, or cases where you just wish to add something to the other field, you can edit and update the catalogue. Nothing is overwritten in the main catalogue, but the information you have provided is displayed in preference to the main catalogue (see later).

In a similar fashion you can add session-related information, and write an observing log using the Notes panel.

The status panel provides useful information about the current state of Jocular e.g. how many stars were found during alignment, how many subs were aligned, total exposure. It also provides a colour-coded indication of the health of each components (red=error, yellow=warning, green=ok). In general, yellowed items won't stop Jocular from running while anything in red ought to be reported to me!

The image statistics panel provides bare-bones information about the range of intensities in the image as well as background estimates. It is mainly there for diagnosing issues with calibration frames at the moment, but will be extended in future to provide e.g. FWHM estimates.

Examining previous captures

Jocular supports reloading of previous captures. This is done by clicking the **prev** icon.

Jocular brings up a table of all the observations it can find. Click on an object in the Name column and it will be reloaded into the main screen.

Name	OT	Con	Session	N	Notes
Messier 27	PN	VUL	02 Oct 20 18:08	37	Lots of structure in
Hickson 93	CG	PEG	02 Oct 20 17:48	19	Also Arp 99
obs 1			02 Oct 20 16:20	4	Warning: no metada
B 143	dn	AQL	23 Sep 20 19:12	34	An island of stars ci
NGC 6756	OC	AQL	23 Sep 20 18:41	16	Interesting to find B
WBL 666	G...	AQR	23 Sep 20 18:35	27	galaxy group
NGC 4289	GX	VIR	23 Sep 20 18:27	17	Wow! Placed not w

Once the image has been reloaded, *you can treat it just like a live observation*, so you can explore different processing parameters and the like. The only differences from live observing are that the stack cannot be cleared, and the capture controls are disabled.

All of the tabular structures used in Jocular can be sorted by clicking on the column headings, and filtered by typing into the boxes below the headings. See the section on Observation Planning for more details.

Naming your captures. The previous section illustrated how the obj panel can be used to search for and name your capture. This can be done at any point during the capture. When the image is saved, the name that appears in the obj panel at the point of saving is used to name the directory where the FITs and metadata are held, and it is the name that appears in the previous observations table. However, it is not mandatory to name your captures. Jocular will use the names obs 1, obs 2 etc. You can rename these (or leave them as they are) at any point by reloading and altering the name in the obj panel.

If you change any metadata such as session or object details when viewing a previously-captured object, you will be asked to save before moving on to the next object. In the case of viewing calibration subs that you collected previously, you will also be given the option of creating a new master calibration frame at the point of saving. This allows you to spend more time offline creating good quality flats, for instance.

Observation planning

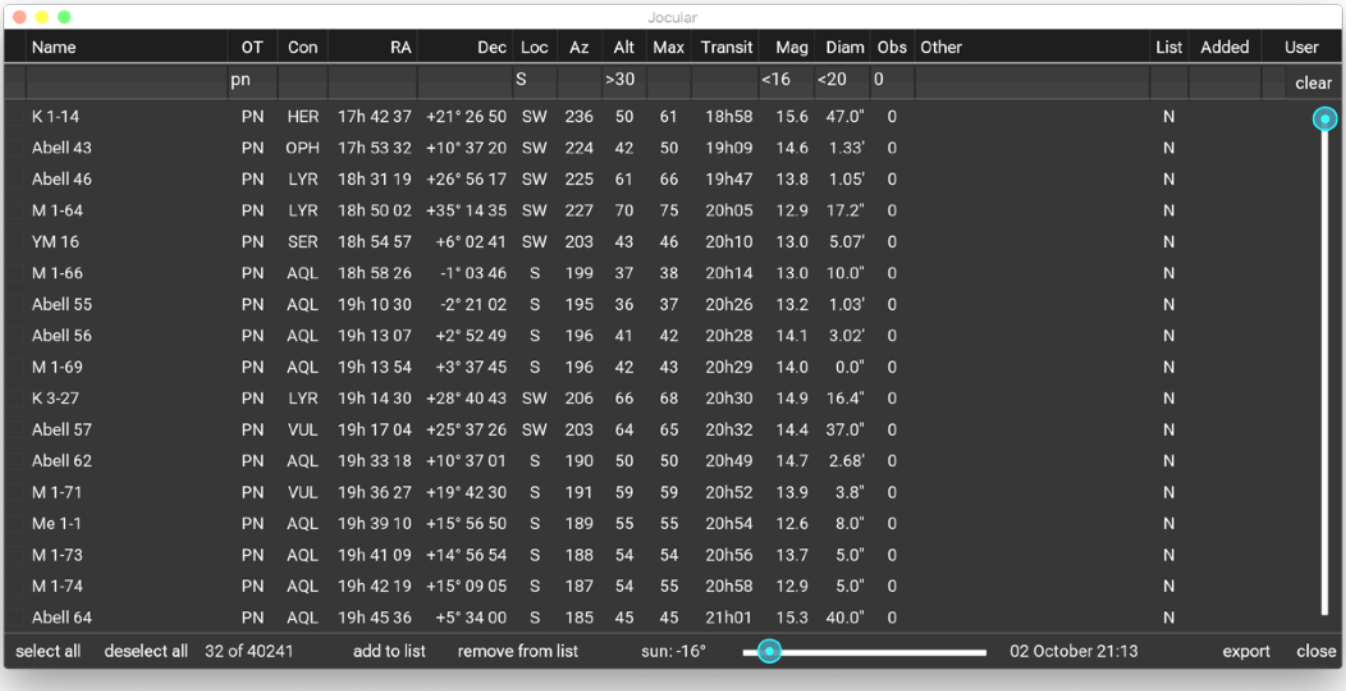
Jocular can also be used to organise your observing plans. This also helps to save typing object names during a live session, as we will see. Objects can be added singly, or in bulk, to an observing list, and using filtering that single observing list can function like multiple separate lists. All of this can be done quickly from a single screen.

Jocular comes with a fairly large collection of object catalogues (you can find them in jocular/etc/catalogues), representing more than 40000 objects. However, you can add your own catalogues by preparing them in a simple format. As we have seen above, you can also add your own entries one by one using the obj panel, and edit existing entries.

Clicking on the **DSOs** icon brings up a tabular view of the combined catalogues. While it is possible to scroll using the scrollbar on the right, it is almost always unnecessary; instead, we will use column filters to find what we want. Typing in the fields below each column restricts the table to matching entries, and judicious use of a few such column filter soon has the table in a more manageable state.

The example below shows all planetary nebulae whose location is towards the south at the specified time (21.13, with the sun 16 degrees below the horizon). What's more, they are all more than 30 degrees above the horizon, are mag 16 or brighter and have an apparent diameter of under 20 arcseconds. Finally, these are objects for which Jocular has no observations (i.e., the observer has not yet observed them with Jocular), and they are sorted by increasing transit time. In this way we can very quickly 'triangulate' a set of future observations.

The next step might be to **select all** and add to list. This will cause the List column to change to Y for these objects, and the date added to appear. These columns can then be filtered in the future to find things on our observing list.



Jocular

Name	OT	Con	RA	Dec	Loc	Az	Alt	Max	Transit	Mag	Diam	Obs	Other	List	Added	User
	pn				S		>30			<16	<20	0				clear
K 1-14	PN	HER	17h 42 37	+21° 26 50	SW	236	50	61	18h58	15.6	47.0"	0		N		
Abell 43	PN	OPH	17h 53 32	+10° 37 20	SW	224	42	50	19h09	14.6	1.33'	0		N		
Abell 46	PN	LYR	18h 31 19	+26° 56 17	SW	225	61	66	19h47	13.8	1.05'	0		N		
M 1-64	PN	LYR	18h 50 02	+35° 14 35	SW	227	70	75	20h05	12.9	17.2"	0		N		
YM 16	PN	SER	18h 54 57	+6° 02 41	SW	203	43	46	20h10	13.0	5.07'	0		N		
M 1-66	PN	AQL	18h 58 26	-1° 03 46	S	199	37	38	20h14	13.0	10.0"	0		N		
Abell 55	PN	AQL	19h 10 30	-2° 21 02	S	195	36	37	20h26	13.2	1.03'	0		N		
Abell 56	PN	AQL	19h 13 07	+2° 52 49	S	196	41	42	20h28	14.1	3.02'	0		N		
M 1-69	PN	AQL	19h 13 54	+3° 37 45	S	196	42	43	20h29	14.0	0.0"	0		N		
K 3-27	PN	LYR	19h 14 30	+28° 40 43	SW	206	66	68	20h30	14.9	16.4"	0		N		
Abell 57	PN	VUL	19h 17 04	+25° 37 26	SW	203	64	65	20h32	14.4	37.0"	0		N		
Abell 62	PN	AQL	19h 33 18	+10° 37 01	S	190	50	50	20h49	14.7	2.68'	0		N		
M 1-71	PN	VUL	19h 36 27	+19° 42 30	S	191	59	59	20h52	13.9	3.8"	0		N		
Me 1-1	PN	AQL	19h 39 10	+15° 56 50	S	189	55	55	20h54	12.6	8.0"	0		N		
M 1-73	PN	AQL	19h 41 09	+14° 56 54	S	188	54	54	20h56	13.7	5.0"	0		N		
M 1-74	PN	AQL	19h 42 19	+15° 09 05	S	187	54	55	20h58	12.9	5.0"	0		N		
Abell 64	PN	AQL	19h 45 36	+5° 34 00	S	185	45	45	21h01	15.3	40.0"	0		N		

select all deselect all 32 of 40241 add to list remove from list sun: -16° 02 October 21:13 export close

Column filters are either
text-based or numeric. In a test-based column such as Name, starting to type NGC… will select all the NGCs (prefix matching). Using an = sign ensures matching of the full string. Wildcards can be used to match other parts of strings e.g. *z* in the Other column matches all objects with a redshift.

Numeric filters are treated as follows. A single number indicates that an exact match is required (e.g. the Obs column). Preceding the number with less than (<) applies what is in fact a less-than-or-equal-to constraint to the column; likewise with greater than (>). The two can be combined e.g >30,<40 select values in the closed interval 30-40.

The column headed User is editable and can be used for (brief) notes e.g. ‘ring’, ‘must observe’, ‘catch late’.

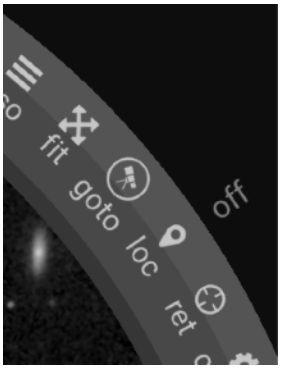
The Loc, Az, Alt, Max (= max altitude reach) and Transit columns require the user to have input their location under the Observatory tab of the configuration screen.

The slider at the base covers 24 hours from the current time and is useful in identifying when the sun is at a given altitude, both for observing and for planning when to take twilight flats.

The export option creates a comma-separated value format text file in the user’s exports directory (within the jocular data directory). The values exported are those that match the current selection.

Using the observation planning table in a live session. By using appropriate filters (e.g. a ‘Y’ in the List column, and perhaps sorted by Added date, along with other filters e.g. Loc), it is easy to make use of the observation table during a live session — it is effectively converted into an observing list. Every time the table is selected from the main screen, the most recent filters are applied, so the observing list appears each time. Why is this useful? Because during a live session, clicking in the Name column will cause that entry to be filled in in the obj panel. In this way, the observing table can save much typing during a live session. Another useful feature is to place a zero in the Obs column. This means that once you have observed an item from your list it no longer appears — very useful if you are working your way through a list during a session. Note that the object does not disappear from the observing list (ie a ‘Y’ is still present in the List column). However, it is a simple matter to select all objects with >0 observations, click **select all** and **remove from list**.

Annotation

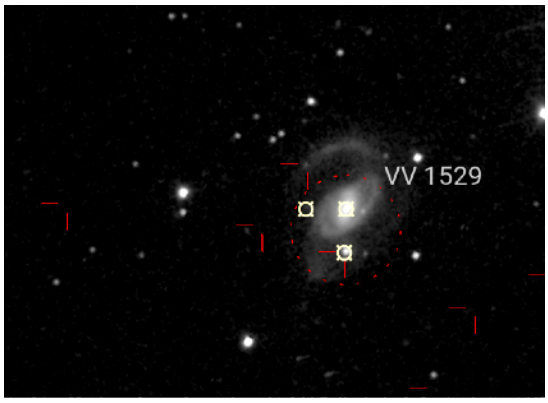


As of v0.4, Jocular supports automatic/customisable annotation of your images. Annotation is based on platesolving, for which you will need to download the platesolving database from the Jocular website: https://transpy.eu.pythonanywhere.com/jocular

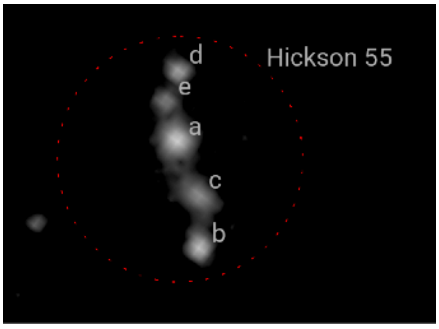
Platesolving is implemented natively in Jocular i.e. it does not make use of any other software. It is non-blind solving and thus needs a DSO name to be chosen (in the object panel at top left).

To configure platesolving, input your focal length, sensor pixel height/binning via the Plate solving panel of the configuration screen. Also ensure that your image has the appropriate 'flips' (see under the View panel) such that there is some rotation that will produce North up and East to the left (ie matching a chart view).

To perform a platesolve, simply click the 'loc' icon. If the solve is successful, the image will be rotated with North upwards. Failures are rare: if you encounter one, check the previous paragraph and consider the possibility that the object is not in the current image. If in doubt, I am very happy to receive FITs that fail; please supply focal length and pixel height/binning.



Annotation depth is controlled by the slider (labelled 'off' in the image). Moving the slider upwards the label changes to 'pin', which displays anything you decided to pin (see below). Moving still further the slider label changes to a numeric magnitude value which acts as a limit on what is displayed. Any objects encounted in the catalogues are displayed as coloured squares, with object type mapping to colour. Hovering the mouse brings up information about the object. Clicking on the square 'pins' the object name/particulars. Clicking again 'unpins' the object. In this way, you can select just those objects you wish to annotate. The target (ie the DSO whose name appears at the top left) is pinned by default, though you can unpin it.

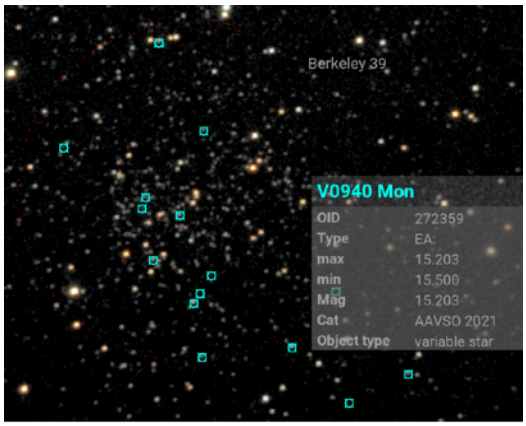


At the extreme of its range, the slider displays group members e.g. individual members of a Shakhkbazian or Hickson group. Clicking on a group member displays the membership character or number. The figure shows the result of displaying the members of Hickson 55 (first by moving the slider to the extreme value, then clicking each square, then moving the slider to the pin position).

A couple of provisos in the current annotation implementation:

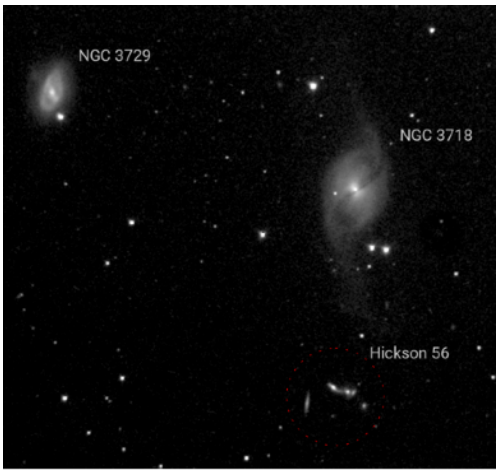
1. Repeating the platesolve resets everything, so anything pinned is lost.
2. Snapshots only preserve annotation labels in Eyepiece mode (not Landscape). This will be fixed in a future version.

Catalogues for deep annotation. Since there are many millions of objects that could conceivably be browsed in this way, the catalogues for really deep annotation are quite large (up to 100M for galaxies, for example) and should be downloaded separately from the Jocular website: https://transpy.eu.pythonanywhere.com/jocular where you will find instructions on what to do with them.



You can download just the ones you need, or all of them. In the latter case you can control the catalogues that Jocular uses via an option on the Catalogues panel in configuration. Simply list the names of the catalogues you do not wish Jocular to use. *Note that in some parts of the sky (e.g. M42) there are thousands of variable stars to annotate which can slow things down*, so you might want to temporarily switch off the VS catalogue using the above procedure.

When annotating, Jocular first queries the 'standard' catalogues (the ones that are visualised in the DSO browser), then looks for any deep catalogues. On encountering two objects with the same name and object type, the deep catalogue takes precedence (normally this contains richer information).



The deep catalogues employ a format that make them very fast to use in spite of millions of members in some cases. If you wish to use something similar in our own applications, let me know and I will send the necessary Python code!

Other features

To supports interoperability between tools, Jocular stores everything in an openly-accessible format, and it is worth exploring the data directories to see how your observations and calibration frames are organised. For instance, if you have FITs files corresponding to earlier observations captured with a different program, it is very easy to add them to the Jocular captures structure so that the next time you start Jocular, it finds them and makes them available to be processed within Jocular. Or in the other direction, you can use Jocular to organise your captures and then process them with a different tool. A simple way to explore Jocular is to manually drop FITs files into the watched directory. If there are no problems, they should appear immediately on Jocular's display. As mentioned earlier, you can also drop calibration masters into the watched directory and they will be validated and moved into Jocular's calibration directory and become available within the calibration library. You might just want to make use of Jocular's annotation functions. Drop your FITs in, name the object and apply platesolving/annotation.

Likewise, feel free to explore the existing catalogues of DSOs that can be found in app/dsos. These are all comma-separated value files that you can export into Excel, for instance, and use to create your own object catalogues. You can download and share new catalogues; so long as they are in the right format, if you place them in the catalogues directory at the top level, they will be read by Jocular on startup. A separate program is available to convert Vizier formats to one Jocular can use in a single command.

Jocular is highly-configurable. Be sure to check all the options in the configuration screen. Note that you can also edit the jocular.ini file in your jocular data directory.

Don't forget to set up your own latitude and longitude so that the transit times, solar altitude etc are correct for your location. This is easily achieved from the configuration screen.

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