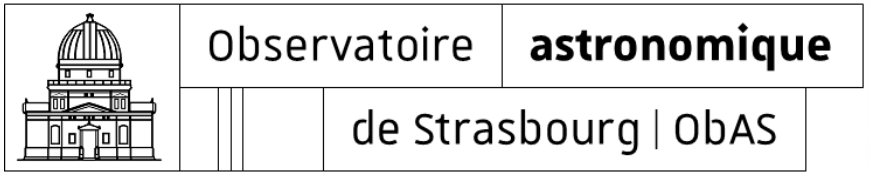
The CDS in a notebook

EAS CDS lunch session

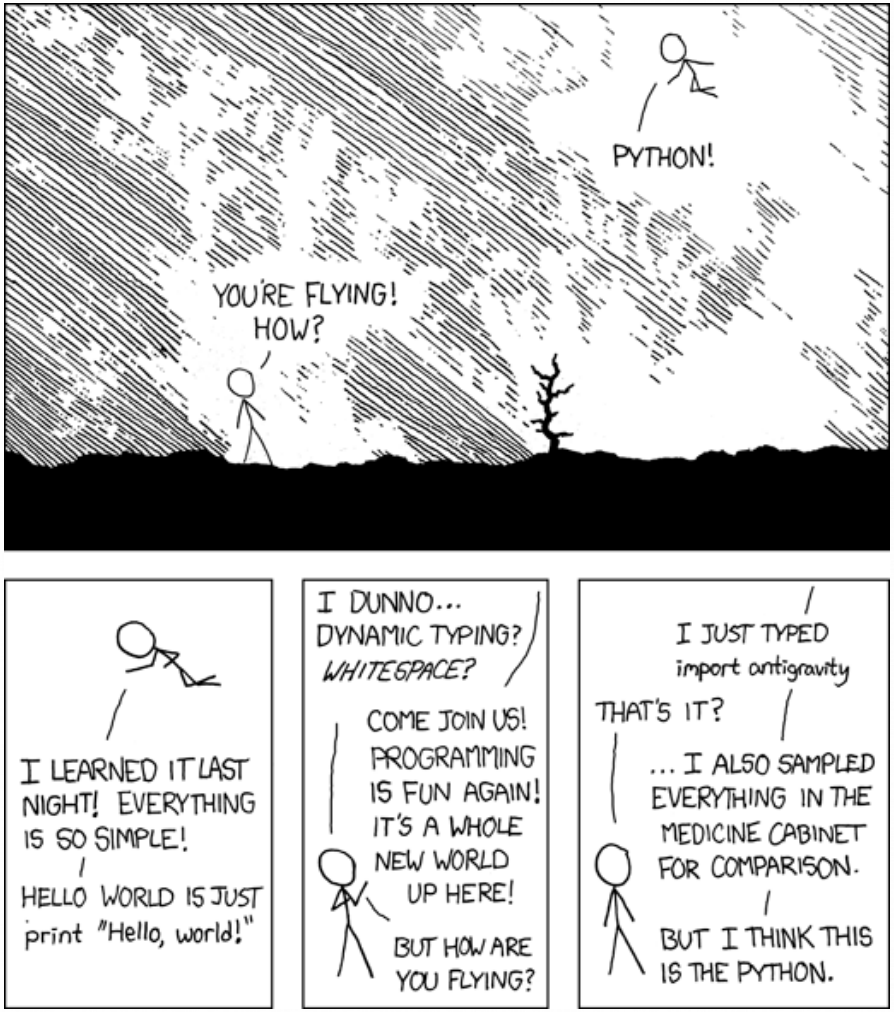
July 2020

KATHARINA LUTZ

CDS TEAM



Why Python?



- usage increasing
- strong astropy ecosystem
- science platforms

Visualisation with ipyaladin

```
In [6]:
1 aladin = ipyal.Aladin(target='M101', fov=0.7, survey='P/DSS2/color')
2 aladin
```

Visualisation with ipyaladin

```
In [6]:
1 aladin = ipyal.Aladin(target='M101', fov=0.7, survey='P/DSS2/color')
2 aladin
```

Change Survey, Manage Layers

Visualisation with ipyaladin

```
In [6]:
1 aladin = ipyal.Aladin(target='M101', fov=0.7, survey='P/DSS2/color')
2 aladin
```

Search for Objects

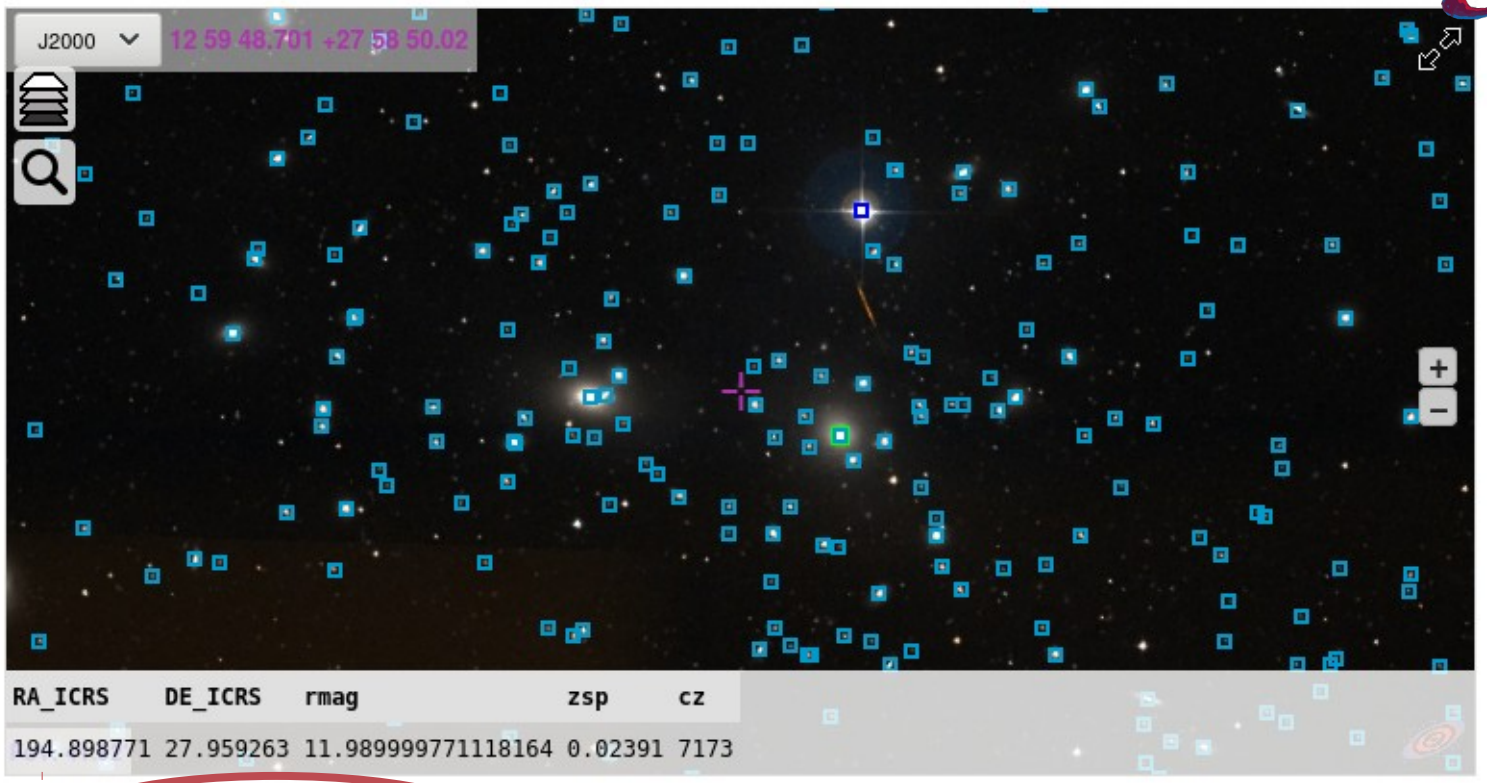
Visualisation with ipyaladin

```
In [6]:
1 aladin = ipyal.Aladin(target='M101', fov=0.7, survey='P/DSS2/color')
2 aladin
```

Zoom in and out

… adding a catalogue

In [3]:
```
1 aladin
```



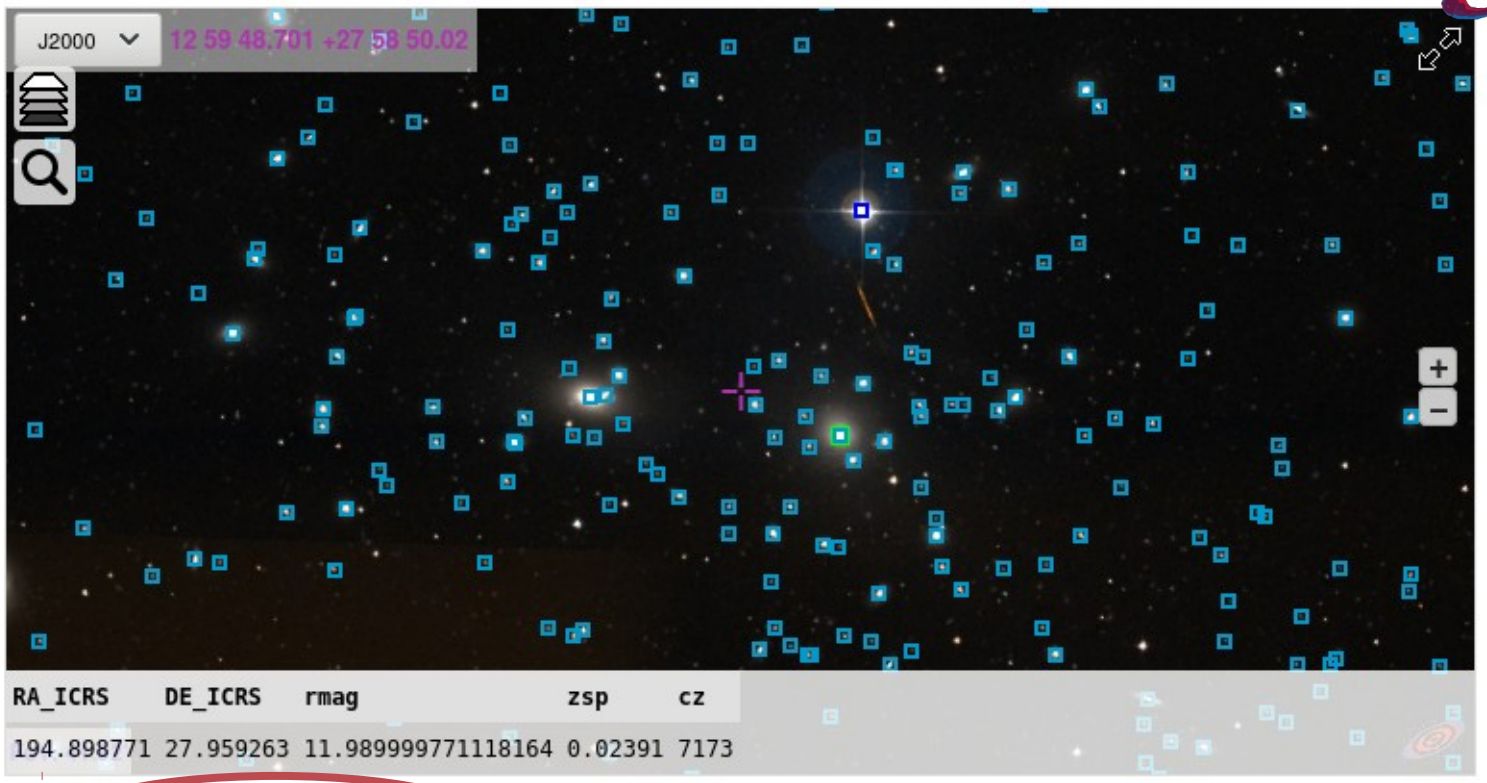
RA_ICRS	DE_ICRS	rmag	zsp	cz
194.898771	27.959263	11.989999771118164	0.02391	7173

In [40]:
```
1 aladin.add_table(galaxies)
```

Manage AladinLite widget with commands

… adding a catalogue

```
In [3]: 1 aladin
```



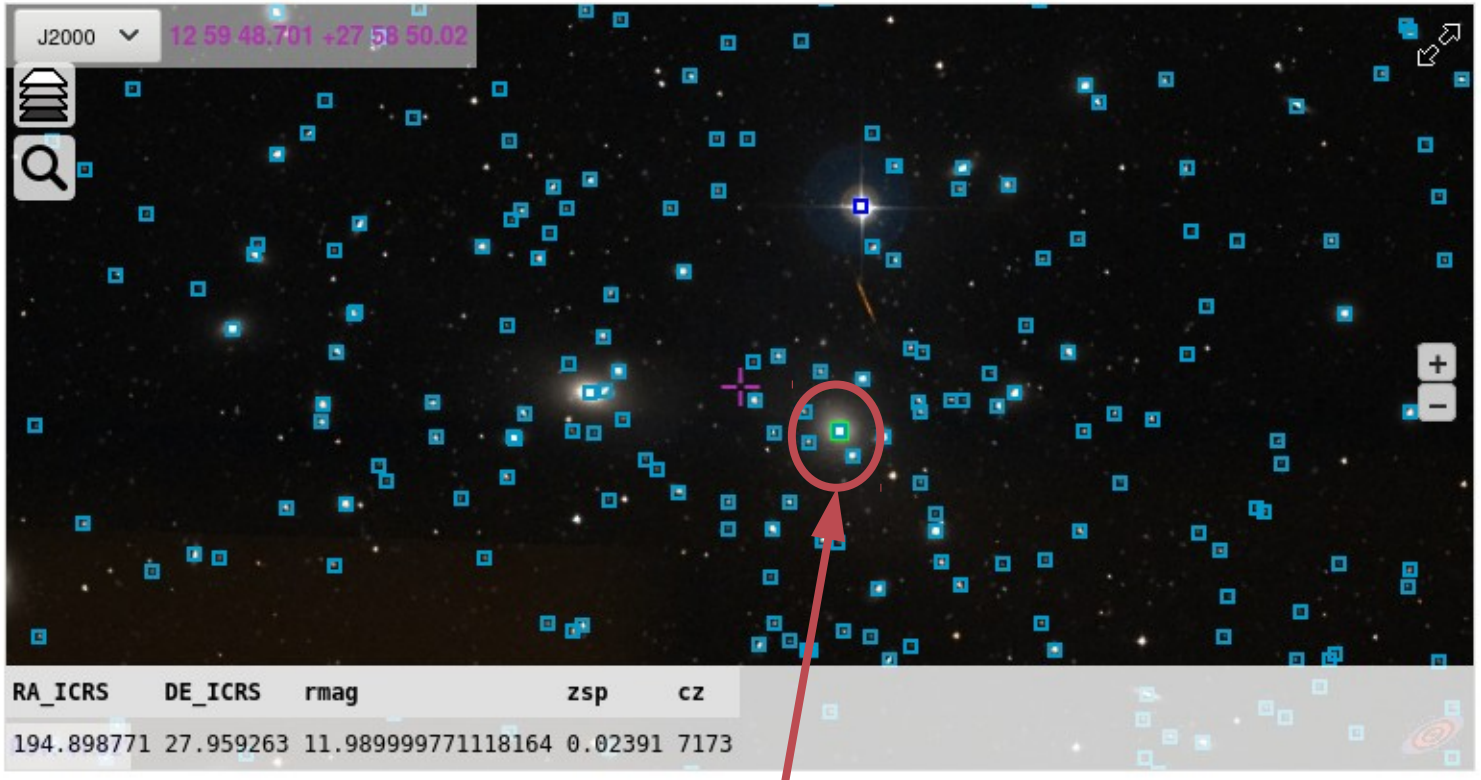
RA_ICRS	DE_ICRS	rmag	zsp	cz
194.898771	27.959263	11.989999771118164	0.02391	7173

```
In [40]: 1 aladin.add_table(galaxies)
```

Add an Astropy Table

… adding a catalogue

```
In [3]: 1 aladin
```



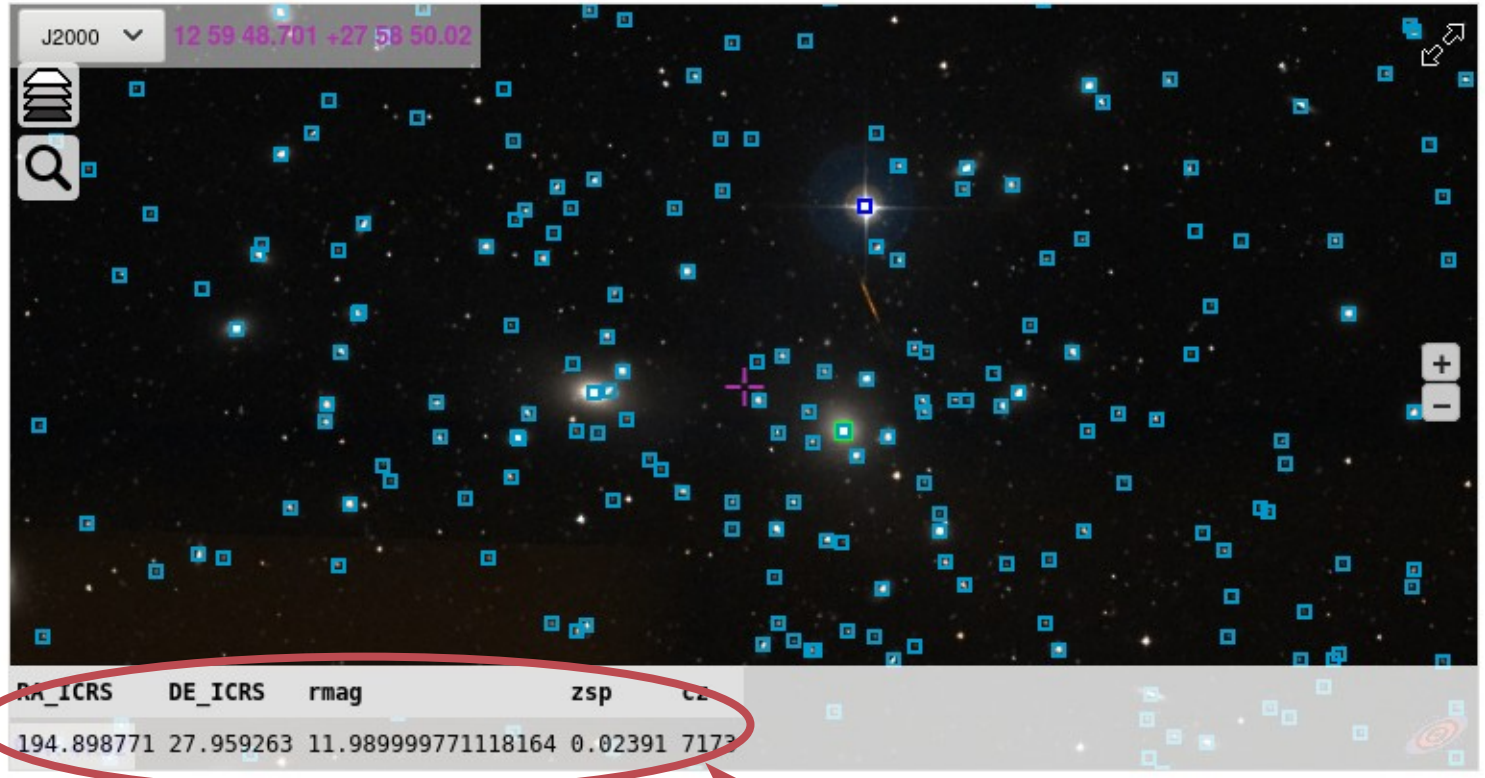
RA_ICRS	DE_ICRS	rmag	zsp	cz
194.898771	27.959263	11.989999771118164	0.02391	7173

```
In [40]: 1 aladin.add_table(galaxies)
```

Select a Table entry

… adding a catalogue

```
In [3]: 1 aladin
```

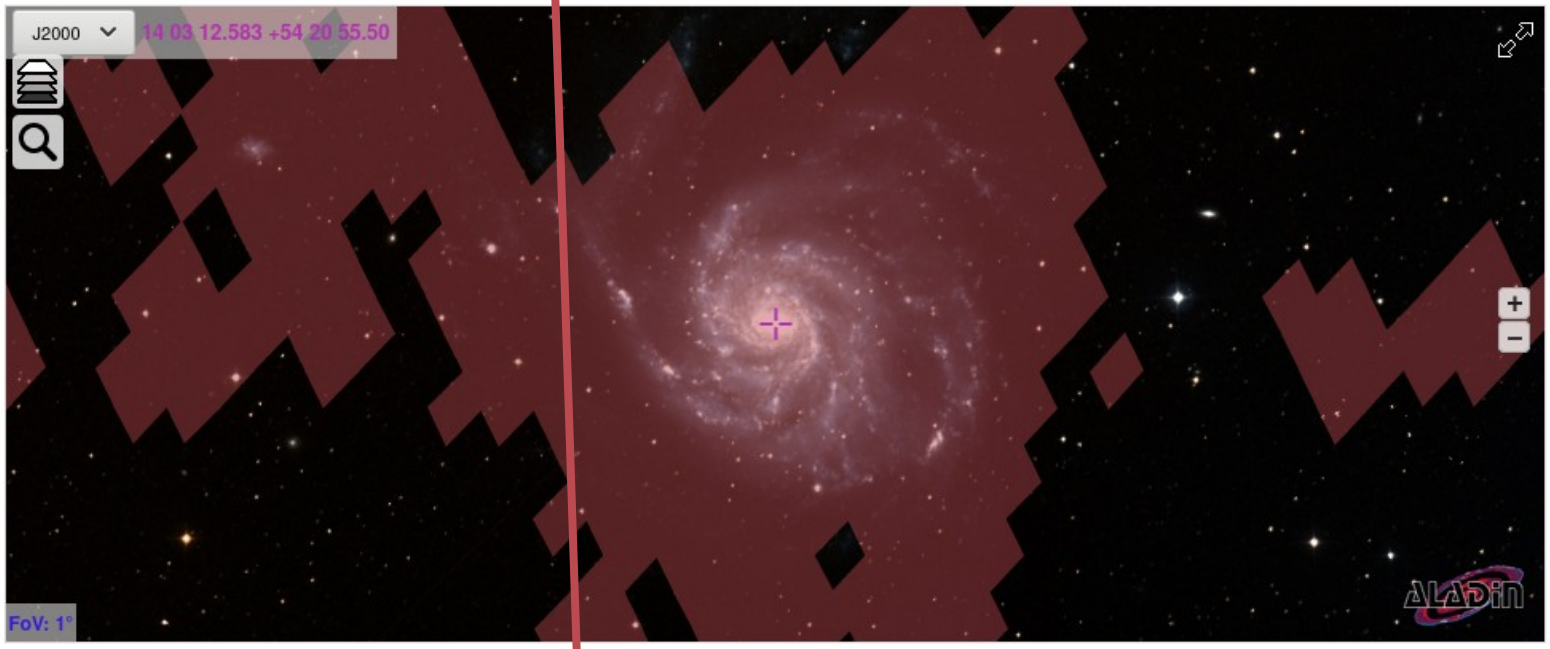



```
In [40]: 1 aladin.add_table(galaxies)
```

See the table values

MOCs and the MOC server

```
In [2]:  moc_1 = cds.find_datasets(meta_data="ID=CDS/P/GALEXGR6/AIS/FUV", return_moc=True)
In [3]:  moc_2 = cds.find_datasets(meta_data="ID=*HST*", return_moc=True)
In [4]:  moc_3 = moc_1.intersection(moc_2)
In [12]: aladin= ipyal.Aladin(survey='P/SDSS/color', target='M101', fov=0.5)
         aladin
```




```
In [13]: aladin.add_moc_from_dict(moc_3.serialize(format='json'),
                                 {'color': '#bc4b51', 'opacity': 0.45, 'name': 'Intersection'})
```

Get coverage maps

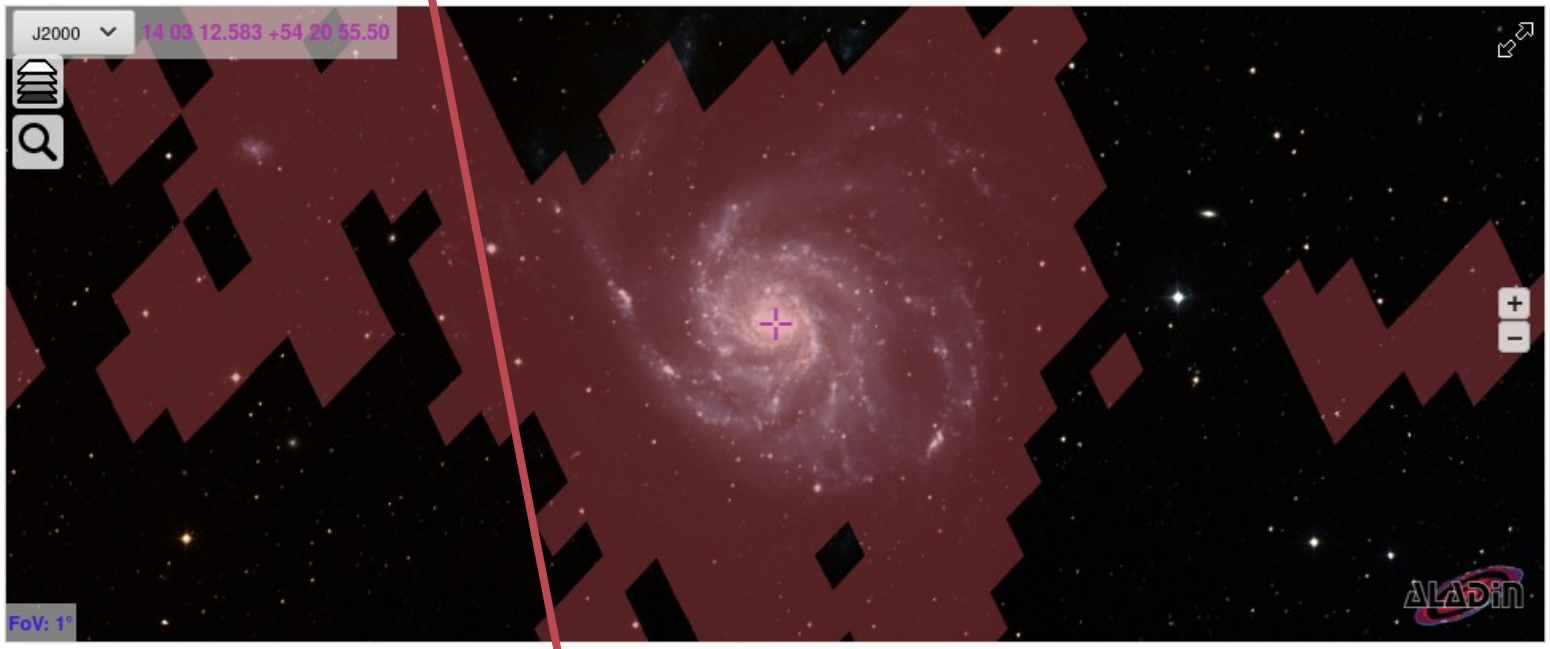
MOCs and the MOC server

```
In [2]:  1  moc_1 = cds.find_datasets(meta_data="ID=CDS/P/GALEXGR6/AIS/FUV", return_moc=True)

In [3]:  1  moc_2 = cds.find_datasets(meta_data="ID=*HST*", return_moc=True)

In [4]:  1  moc_3 = moc_1.intersection(moc_2)

In [12]: 1  aladin= ipyal.Aladin(surve 'P/SDSS/color', target='M101', fov=0.5)
         2  aladin
```




```
In [13]: 1  aladin.add_moc_from_dict(moc_3.serialize(format='json'),
         2                          {'color': '#bc4b51', 'opacity': 0.45, 'name': 'Intersection'})
```

Calculate the intersection

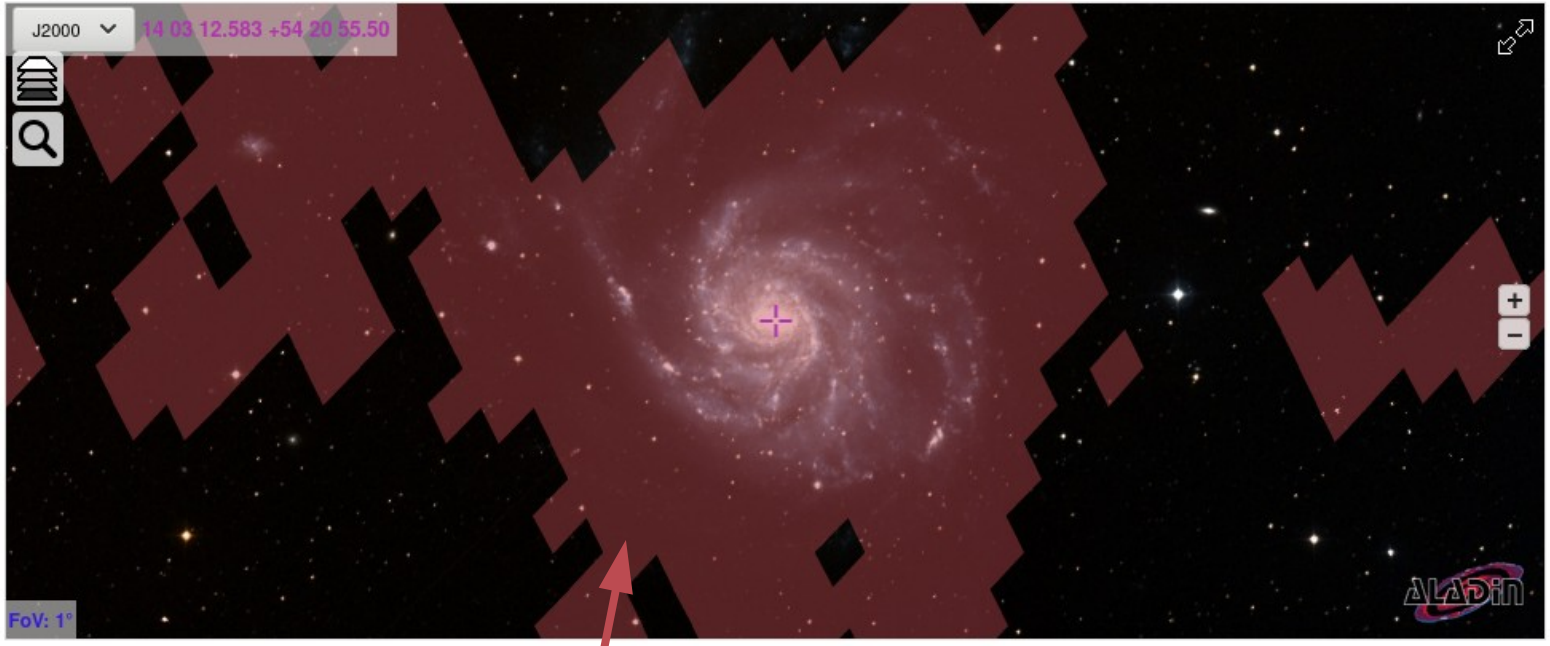
MOCs and the MOC server

In [2]:
```
moc_1 = cds.find_datasets(meta_data="ID=CDS/P/GALEXGR6/AIS/FUV", return_moc=True)
```

In [3]:
```
moc_2 = cds.find_datasets(meta_data="ID=*HST*", return_moc=True)
```

In [4]:
```
moc_3 = moc_1.intersection(moc_2)
```

In [12]:
```
aladin= ipyal.Aladin(survey='P/SDSS/color', target='M101', fov=0.5)
aladin
```



In [13]:
```
aladin.add_moc_from_dict(moc_3.serialize(format='json'),
                         {'color': '#bc4b51', 'opacity': 0.45, 'name': 'Intersection'})
```

The intersection

Tables from VizieR

- astroquery -

Search for all catalogues to do with “SDSS DR9”

```
In [4]:
1 catalog_list_sdss = Vizier.find_catalogs('SDSS DR9')
2 for k, v in catalog_list_sdss.items():
3     print(k, ': ', v.description)
```

```
II/336 :  AAVSO Photometric All Sky Survey (APASS) DR9 (Henden+, 2016)
V/139 :  The SDSS Photometric Catalog, Release 9 (Adelman-McCarthy+, 2012)
IX/48 :  Allsky cross-matched 3XMMe catalogue (Motch+, 2016)
J/A+A/547/L1 :  SDSS-III DR9 DLA catalogue (Noterdaeme+, 2012)
J/A+A/598/A92 :  New ultracool subdwarfs (Lodieu+, 2017)
J/A+A/616/A97 :  SDSS QSO DR7 and DR9 (D'Isanto+, 2018)
J/MNRAS/444/2456 :  Spectral galaxy pairs from SDSS DR9 (Yang+, 2014)
J/MNRAS/445/1331 :  White-dwarf + main-sequence binaries in SDSS DR9 (Li+, 2014)
J/MNRAS/450/905 :  New SNe in SDSS DR9 (Graur+, 2015)
J/MNRAS/458/3808 :  DR9-12 SDSS WDMS binaries (Rebassa-Mansergas+, 2016)
J/other/NewA/58.61 :  SDSS DR9 galaxy clusters optical catalog (Banerjee+, 2018)
J/other/RAA/17.62 :  Candidate members of 4 stellar streams (Li+, 2017)
```

Tables from VizieR

- astroquery -

In [4]:
```
1 catalog_list_sdss = Vizier.find_catalogs('SDSS DR9')
2 for k, v in catalog_list_sdss.items():
3     print(k, ': ', v.description)
```

```
J/A+A/626/A96 :  AAVSO Photometric All Sky Survey (APASS) DR9 (Henden+, 2016)
V/139 :  The SDSS Photometric Catalog, Release 9 (Adelman-McCarthy+, 2012)
IX/48 :  Allsky cross-matched 3XMMe catalogue (Motch+, 2016)
J/A+A/547/L1 :  SDSS-III DR9 DLA catalogue (Noterdaeme+, 2012)
J/A+A/598/A92 :  New ultracool subdwarfs (Lodieu+, 2017)
J/A+A/616/A97 :  SDSS QSO DR7 and DR9 (D'Isanto+, 2018)
J/MNRAS/444/2456 :  Spectral galaxy pairs from SDSS DR9 (Yang+, 2014)
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J/MNRAS/450/905 :  New SNe in SDSS DR9 (Graur+, 2015)
J/MNRAS/458/3808 :  DR9-12 SDSS WDMS binaries (Rebassa-Mansergas+, 2016)
J/other/NewA/58.61 :  SDSS DR9 galaxy clusters optical catalog (Banerjee+, 2018)
J/other/RAA/17.62 :  Candidate members of 4 stellar streams (Li+, 2017)
```

Get the ID of a catalogue

Tables from VizieR

- pyVO -

```
In [2]:
1 tap_vizier = pyvo.dal.TAPService('http://tapvizier.u-strasbg.fr/TAPVizieR/tap')
2 mass_psc_set = tap_vizier.search("SELECT * FROM tables " +
3                                  "WHERE description LIKE '%2MASS%Cutri%'").to_table()
4 mass_psc_set['table_name', 'description']
```

Out[2]: *Table length=13*

table_name	description
bytes36	object
J/ApJ/564/421/table6	New T Dwarfs Identified in the 2MASS Catalog (Burgasser A.J., Kirkpatrick J.D., Brown M.E., Reid I.N., Burrows A., Liebert J., Matthews K., Gizis J.E., Dahn C.C., Monet D.G., Cutri R.M., Skrutskie M.F.)
J/ApJ/569/23/table3	Galactic interstellar polarization detected in the fields of 2MASS AGNs (Smith P.S., Schmidt G.D., Hines D.C., Cutri R.M., Nelson B.O.)
II/246/out	2MASS Point Source Catalogue, output (on a total of 470,992,970 sources) (Cutri R.M., Skrutskie M.F., Van Dyk S., et al.)
J/ApJ/569/23/table1	Optical polarimetry of 2MASS Red QSOs (Smith P.S., Schmidt G.D., Hines D.C., Cutri R.M., Nelson B.O.)
J/ApJ/569/23/table2	Optical polarimetry of other AGN found by 2MASS (Smith P.S., Schmidt G.D., Hines D.C., Cutri R.M., Nelson B.O.)

44.996055	0.005565	0.17	0.16	76	02595905+0000200	16.376	0.097	0.097	11.3	15.77	0.139	0.14
45.004857	0.019806	0.06	0.06	90	03000116+0001113	12.529	0.021	0.024	389.8	11.954	0.029	0.03
45.004193	0.020956	0.06	0.06	90	03000100+0001154	14.845	0.055	0.056	46.2	14.223	0.077	0.077

Find a catalogue in the table of catalogues

Tables from VizieR

- pyVO -

```
In [2]:
1 tap_vizier = pyvo.dal.TAPService('http://tapvizier.u-strasbg.fr/TAPVizieR/tap')
2 mass_psc_set = tap_vizier.search("SELECT  *  FROM tables " +
3                                  "WHERE description LIKE '%2MASS%Cutri%'").to_table()
4 mass_psc_set['table_name', 'description']
```

Get data from a catalogue

bytes36	object
J/ApJ/564/421/table6	New T Dwarfs Identified in the 2MASS Catalog (Burgasser A.J., Kirkpatrick J.D., Brown M.E., Reid I.N., Burrows A., Liebert J., Matthews K., Gizis J.E., Dahn C.C., Monet D.G., Cutri R.M., Skrutskie M.F.)
J/ApJ/569	Galactic interstellar polarization detected in the fields of 2MASS AGNs (Smith P.S., Schmidt G.D., Hines D.C., Cutri R.M.,

```
In [3]:
1 mass_psc_head = tap_vizier.search("SELECT TOP 5 * FROM \"II/246/out\" ").to_table()
2 mass_psc_head
```

Out[3]: *Table length=5*

RAJ2000	DEJ2000	errMaj	errMin	errPA	2MASS	Jmag	Jcmsig	e_Jmag	Jsnr	Hmag	Hcmsig	e_Hmag	
deg	deg	arcsec	arcsec	deg		mag	mag	mag		mag	mag	mag	
float64	float64	float32	float32	int16	bytes17	float32	float32	float32	float64	float32	float32	float32	fl
44.996055	0.005565	0.17	0.16	76	02595905+0000200	16.376	0.097	0.097	11.3	15.77	0.139	0.14	
45.004857	0.019806	0.06	0.06	90	03000116+0001113	12.529	0.021	0.024	389.8	11.954	0.029	0.03	
45.004193	0.020956	0.06	0.06	90	03000100+0001154	14.845	0.055	0.056	46.2	14.223	0.077	0.077	
44.995074	0.038204	0.38	0.31	0	02595881+0002175	16.746	0.133	0.134	8.0	15.814	0.139	0.14	
44.963851	0.043587	0.22	0.17	95	02595132+0002369	16.476	0.112	0.113	10.3	16.057	0.175	0.175	

Associated data from VizieR

```
In [4]:
1 mash_fits = tap_vizier.search("SELECT TOP 5  *  FROM obscore " +
2                               "WHERE obs_collection='J/ApJ/727/A'").to_table()
3 mash_fits
```

olution	em_min	em_max	em_band	o_ucd	pol_states	facility_name	instrument_name	access_url	access_format	ac
float64	float64	float64	object	object	object	object	object	object	object	
--	3e-07	1e-06	Optical	obs.image	NotSet	UKST	SuperCOSMOS I	http://cdsarc.u-strasbg.fr/saadavizier/download?oid=864972848244981761	application/fits	

Get entries from table of associated data

Associated data from VizieR

```
In [4]:
1 mash_fits = tap_vizier.search("SELECT TOP 5  *  FROM obscore " +
2                               "WHERE obs_collection='V/127A'").to_table()
3 mash_fits
```

olution	em_min	em_max	em_band	o_ucd	pol_states	facility_name	instrument_name	access_url	access_format	ac
float64	float64	float64	object	object	object	object	object	object	object	
--	3e-07	1e-06	Optical	obs.image	NotSet	UKST	SuperCOSMOS I	http://cdsarc.u-strasbg.fr/saadavizier/download?oid=864972848244981761	application/fits	

URL of associated data

XMatch

```
In [10]:
1 sdss_mass = XMatch.query(cat1=open('Data/2MASS_PSC.vot'),
2                          cat2='vizier:V/139/sdss9',
3                          max_distance=4 * u.arcsec,
4                          colRA1='RAJ2000', colDec1='DEJ2000')
5 sdss_mass
```

Out[10]: *Table length=717*

angDist	RAJ2000	DEJ2000	errMaj	errMin	errPA	2MASS	Jmag	Jcmsig	e_Jmag	Jsnr	Hmag	Hcmsig
float64	float64	float64	float64	float64	int64	str16	float64	float64	float64	float64	float64	float64
0.352101	127.509154	1.269173	0.2	0.15	87	08300219+0116090	15.963	0.095	0.096	12.5	15.546	0.121
0.152435	127.507779	1.272875	0.12	0.11	86	08300186+0116223	15.594	0.083	0.084	17.6	15.563	0.117
0.217574	127.514167	1.277495	0.23	0.21	51	08300340+0116389	16.553	0.17	0.171	7.3	16.179	0.194
0.048922	127.463251	1.271903	0.07	0.07	0	08295118+0116188	15.844	0.076	0.077	14.0	15.11	0.095
0.023156	127.463023	1.2864	0.06	0.06	0	08295112+0117110	14.093	0.029	0.032	70.0	13.652	0.033
0.102852	127.48465	1.271192	0.06	0.06	0	08295631+0116162	13.848	0.026	0.029	87.8	13.177	0.02
0.385255	127.485565	1.275456	0.2	0.17	4	08295653+0116316	16.26	0.112	0.112	9.5	15.908	0.172
0.18744	127.494339	1.280734	0.15	0.15	145	08295864+0116506	16.317	0.119	0.12	9.0	15.818	0.141

Local table

XMatch

```
In [10]:
1 sdss_mass = XMatch.query(cat1=open('Data/2MASS_PSC.vot'),
2                          cat2='vizier:V/139/sdss9',
3                          max_distance=4 * u.arcsec,
4                          colRA1='RAJ2000', colDec1='DEJ2000')
5 sdss_mass
```

Out[10]: *Table length=717*

angDist	RAJ2000	DEJ2000	errMaj	errMin	errPA	2MASS	Jmag	Jcmsig	e_Jmag	Jsnr	Hmag	Hcmsig
float64	float64	float64	float64	float64	int64	str16	float64	float64	float64	float64	float64	float64
0.352101	127.509154	1.269173	0.2	0.15	87	08300219+0116090	15.963	0.095	0.096	12.5	15.546	0.121
0.152435	127.507779	1.272875	0.12	0.11	86	08300186+0116223	15.594	0.083	0.084	17.6	15.563	0.117
0.217574	127.514167	1.277495	0.23	0.21	51	08300340+0116389	16.553	0.17	0.171	7.3	16.179	0.194
0.048922	127.463251	1.271903	0.07	0.07	0	08295118+0116188	15.844	0.076	0.077	14.0	15.11	0.095
0.023156	127.463023	1.2864	0.06	0.06	0	08295112+0117110	14.093	0.029	0.032	70.0	13.652	0.033
0.102852	127.48465	1.271192	0.06	0.06	0	08295631+0116162	13.848	0.026	0.029	87.8	13.177	0.02
0.385255	127.485565	1.275456	0.2	0.17	4	08295653+0116316	16.26	0.112	0.112	9.5	15.908	0.172
0.18744	127.494339	1.280734	0.15	0.15	145	08295864+0116506	16.317	0.119	0.12	9.0	15.818	0.141

VizieR table

Bibliography from SIMBAD

In [19]:
```
tap_simbad = pyvo.dal.TAPService('http://simbad.u-strasbg.fr:80/simbad/sim-tap')
result = tap_simbad.search("SELECT BIBCode, " +
                           "       Journal, " +
                           "       Title, " +
                           "       \"year\", " +
                           "       Volume, " +
                           "       Page || '-' || Last_Page AS \"Pages\", " +
                           "       DOI " +
                           "FROM ref JOIN has_ref ON oidbibref = oidbib " +
                           "     JOIN ident ON has_ref.oidref = ident.oidref " +
                           "WHERE id = 'M13' " +
                           "ORDER BY \"year\" DESC; ").to_table()
result
```

Out[19]: *Table length=1975*

bibcode	journal	title	year	volume	Pages	doi
object	object	object	int16	int32	object	object
2019MNRAS.485.4625B	MNRAS	Chemical abundances of open clusters from high-resolution infrared spectra - I. NGC 6940.	2019	485	4625-4640	10.1093/mnras/stz727
2019MNRAS.485.3042S	MNRAS	Homogeneous photometry - VII. Globular clusters in the Gaia era.	2019	485	3042-3063	10.1093/mnras/stz585
2019A&A...624A..24C	A&A	Empirical estimates of the Na-O anti-correlation in 95 Galactic globular clusters.	2019	624	24-24	10.1051/0004-6361/201935110

SIMBAD table of references

Bibliography from SIMBAD

In [19]:
```
tap_simbad = pyvo.dal.TAPService('http://simbad.u-strasbg.fr:80/simbad/sim-tap')
result = tap_simbad.search("SELECT BIBCode, " +
                           "       Journal, " +
                           "       Title, " +
                           "       \"year\", " +
                           "       Volume, " +
                           "       Page || '-' || Last_Page AS \"Pages\", " +
                           "       DOI " +
                           "FROM ref JOIN has_ref ON oidbibref = oidbib " +
                           "         JOIN ident ON has_ref.oidref = ident.oidref " +
                           "WHERE id = 'M13' " +
                           "ORDER BY \"year\" DESC; ").to_table()
result
```

Out[19]: *Table length=1975*

bibcode	journal	title	year	volume	Pages	doi
object	object	object	int16	int32	object	object
2019MNRAS.485.4625B	MNRAS	Chemical abundances of open clusters from high-resolution infrared spectra - I. NGC 6940.	2019	485	4625-4640	10.1093/mnras/stz727
2019MNRAS.485.3042S	MNRAS	Homogeneous photometry - VII. Globular clusters in the Gaia era.	2019	485	3042-3063	10.1093/mnras/stz585
2019A&A...624A..24C	A&A	Empirical estimates of the Na-O anti-correlation in 95 Galactic globular clusters.	2019	624	24-24	10.1051/0004-6361/201935110

SIMBAD table of all identifiers

Bibliography from SIMBAD

In [19]:
```
tap_simbad = pyvo.dal.TAPService('http://simbad.u-strasbg.fr:80/simbad/sim-tap')
result = tap_simbad.search("SELECT BIBCode, " +
                           "       Journal, " +
                           "       Title, " +
                           "       \"year\", " +
                           "       Volume, " +
                           "       Page || '-' || Last_Page AS \"Pages\", " +
                           "       DOI " +
                           "FROM ref JOIN has_ref ON oidbibref = oidbib " +
                           "         JOIN ident ON has_ref.oidref = ident.oidref " +
                           "WHERE id = 'M13' " +
                           "ORDER BY \"year\" DESC; ").to_table()
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```

Out[19]: *Table length=1975*

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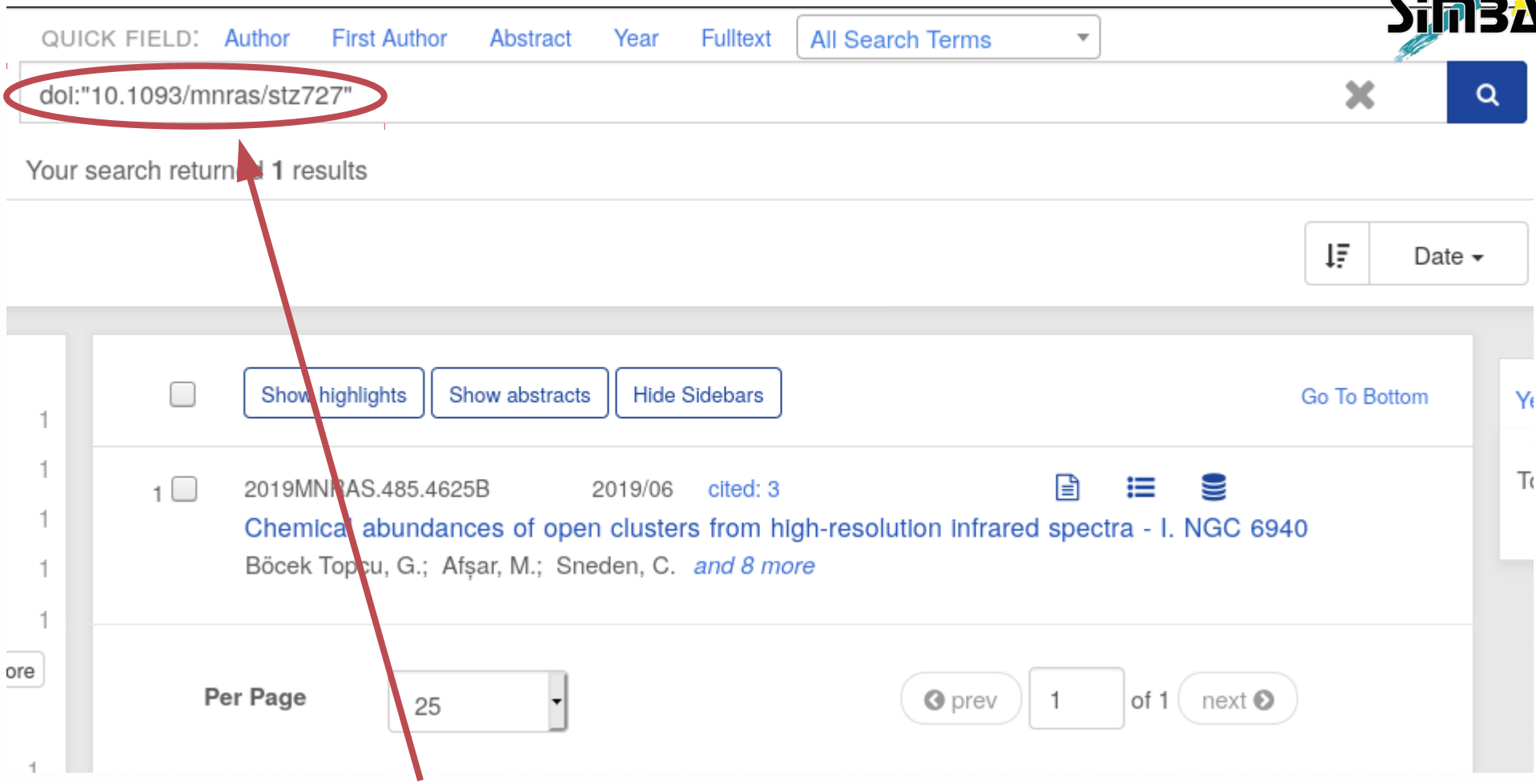
2019MNRAS.485.3042S	MNRAS	Homogeneous photometry - VII. Globular clusters in the Gaia era.	2019	485	3042-3063	10.1093/mnras/stz585
2019A&A...624A..24C	A&A	Empirical estimates of the Na-O anti-correlation in 95 Galactic globular clusters.	2019	624	24-24	10.1051/0004-6361/201935110

DOI of publication

Bibliography from SIMBAD



DOI of publication

Object Types from SIMBAD

In [16]:
```
customSimbad = Simbad()
customSimbad.remove_votable_fields('coordinates')
customSimbad.add_votable_fields('ra(2;A;ICRS;J2000;2000)',
                                'dec(2;D;ICRS;J2000;2000)',
                                'otype')
candidate_coord = SkyCoord(ra=candidates['RAJ2000'][0],
                           dec=candidates['DEJ2000'][0],
                           unit=u.deg)
candidate_simbad = customSimbad.query_region(candidate_coord, radius=10 * u.arcsec)
candidate_simbad
```

Out[16]: *Table length=1*

MAIN_ID	RA_2_A_ICRS_J2000_2000	DEC_2_D_ICRS_J2000_2000	OTYPE
	"h:m:s"	"d:m:s"	
object	str13	str13	object
2MASS J08304878+0128311	08 30 48.784	+01 28 31.15	brownD*

Get object type and coordinates in hexadecimal format

Object Types from SIMBAD

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```
customSimbad = Simbad()
customSimbad.remove_votable_fields('coordinates')
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Re-discovery of a Brown Dwarf, hurray!

Help us to help you

- please avoid DDoS attacks on our servers ;)
  - running queries in a loop might just do that
  - if you have many objects, use those query functions that support the submission of object or coordinate lists

Which package for which service?

Aladin: ipyaladin (hips2fits)

SIMBAD: astroquery, PyVO

VizieR: astroquery, PyVO

XMatch: astroquery

MOC server: astroquery, MOCpy

www.astrobetter.com

https://github.com/cds-astro/tutorials