A Quarter-Century (Almost) of Spectra from FAST

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The FAST Spectrograph

The SAO FAST Spectrograph is a high-throughput optical spectrograph mounted at the Cassegrain focus of the 1.5-meter Tillinghast Reflector at Fred L. Whipple Observatory on the ridge of Mt. Hopkins in Arizona. It has a 3-arcminute-long slit and is typically operated at resolutions between 1 and 6 Å. In its most common configuration, with a 300 line/mm grating and a 3.0 arc-second wide slit, it offers 4000 Å of spectral coverage at 3 Å resolution. 600 and 1200 line/mm gratings can also be used with narrower apertures for increased resolution over smaller spectral ranges. Optics are primarily reflective, for a maximum 26% throughput, and the graphite-epoxy composite construction results in low flexure and good focus stabilty for high throughput.

The FAST Data Reduction Pipeline

Since first light in January, 1994, FAST has had 4 different CCD detectors, but we have run the same pipeline since the beginning, although for many years, it was run only on data observed in the standard configuration of the 300-line grating.

FASTLOG creates a digital log for the night.

FASTSORT sends the raw data for a night to separate reduction directories for each configuration observed.

FASTHEAD is run in each directory to make sure that the FAST configuration is really the same for each spectrum image match

ROADRUNNER is then run to process the images
The original reduction pipeline processed the images, extracted a single object spectrum, and then applied a wavelength solution. Since 2005, we have applied the wavelength solution to the entire image, preserving the spectrum of the entire slit length in a 2-dimensional image.

BEEPBEEP finds the object on the slit, extracts it into a one-dimensional sky-subtracted spectrum image (preserving the original, sky, and variance spectra), finds a velocity using RVSAO, and allows the user to check the results and assign a quality (Q,?,X). At this point the user can switch to the result from an alternative template or manually repair the spectrum and re-cross-correlate it.

FASTARC adds the resulting spectrum metadata to a catalog and moves the spectra to the data archive.

FAST Observations

138,000 spectra of 62,000 different objects have been observed by FAST and reduced into our archive. As every configuration is now reduced, we are working backward to reduced spectra taken in nonstandard configurations.

FAST has been used to observe everything from Near-Earth asteroids to more distant solar system objects to stars near and far, alone or in clusters, and galaxies. Here are some of FAST's major observing projects:

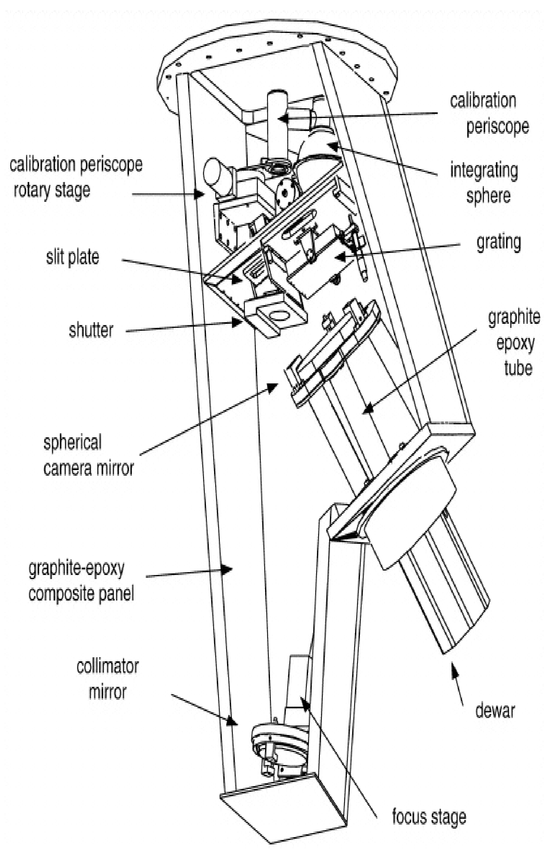
CfA Galaxy Redshift Survey – Margaret Geller and John Huchra
Supernova Followup Program – Robert Kirshner and team
Symbiotic Stars – Scott Kenyon
White Dwarfs – Warren Brown
2MASS Redshift Survey – John Huchra and team
DASCH Long-Period Variable Stars – Su Min Tang

FAST Catalog Sample

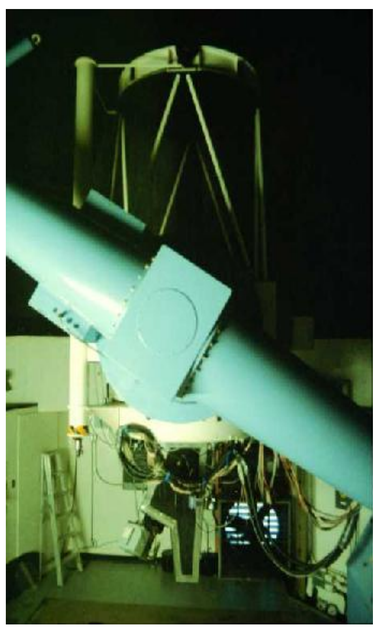
Here are the first 5 and last 5 entries in the flat tab-separated table database. Configuration is B[binning]D[grating lines]T[grating tilt]A[aperture]

object	ra	dec	hjd	prog	pi	wl1	wl2	config	velocity	error	val	rfn	path
07302p2410	07:33:13.282	+24:03:29.68	2449364.71235	99	Huchra	3629.62	7445.04	B1D300T600A3.0	7581.313	10.862	Q	19940111.0015	/home/fast/arch/1994/1994.0111/0015.07302p2410.ms.fits
07224p0918	07:25:07.906	+09:12:01.89	2449364.72425	99	Huchra	3629.93	7445.34	B1D300T600A3.0	13937.031	8.917	Q	19940111.0017	/home/fast/arch/1994/1994.0111/0017.07224p0918.ms.fits
N2402A	07:30:44.304	+09:38:39.12	2449364.73664	99	All	3630.16	7445.56	B1D300T600A3.0	5311.408	11.112	Q	19940111.0019	/home/fast/arch/1994/1994.0111/0019.N2402A.ms.fits
N2402B	07:30:44.304	+09:38:39.12	2449364.74594	99	All	3630.40	7445.70	B1D300T600A3.0	5289.199	7.414	Q	19940111.0021	/home/fast/arch/1994/1994.0111/0021.N2402B.ms.fits
07336p1723	07:36:28.82	+17:16:16.31	2449364.89154	1	Huchra	3630.80	7446.03	B1D300T600A3.0	12821.571	6.444	Q	19940111.0023	/home/fast/arch/1994/1994.0111/0023.07336p1723.ms.fits
07340p0416	07:36:38.244	+04:09:15.18	2449364.77981	99	Huchra	3630.97	7446.21	B1D300T600A3.0	2727.558	6.746	Q	19940111.0025	/home/fast/arch/1994/1994.0111/0025.07340p0416.ms.fits
07371p1721	07:39:58.649	+17:14:02.36	2449364.79045	99	Huchra	3631.20	7446.37	B1D300T600A3.0	13080.829	11.553	Q	19940111.0027	/home/fast/arch/1994/1994.0111/0027.07371p1721.ms.fits
U3960	07:40:23.908	+23:16:00.93	2449364.79986	1	Huchra	3631.34	7446.60	B1D300T600A3.0	2219.985	7.326	Q	19940111.0029	/home/fast/arch/1994/1994.0111/0029.U3960.ms.fits
...													
J2132p28	21:32:15.216	+28:20:41.1	2458018.850364	178	Brown_/_Kilic	3537.64	5526.75	B4D600T445A1.5	0.942	11.942	Q	20170921.0097	/home/fast/arch/2017/2017.0921/0097.j2132p28.ms.fits
j2133m04	21:33:00.768	-04:41:58.34	2458018.865777	178	Brown_/_Kilic	3537.21	5526.17	B4D600T445A1.5	-22.167	12.596	Q	20170921.0099	/home/fast/arch/2017/2017.0921/0099.j2133m04.ms.fits
J2308p02	23:08:55.512	+02:54:25.87	2458018.884877	178	Brown_/_Kilic	3537.50	5526.57	B4D600T445A1.5	281.534	7.269	Q	20170921.0101	/home/fast/arch/2017/2017.0921/0101.j2308p02.ms.fits
J2342p24	23:42:30.216	+24:54:07.92	2458018.904183	178	Brown_/_Kilic	3537.71	5526.83	B4D600T445A1.5	95.946	19.820	Q	20170921.0103	/home/fast/arch/2017/2017.0921/0103.j2342p24.ms.fits
j2343p10	23:43:56.064	+10:59:20.54	2458018.940362	178	Brown_/_Kilic	3537.33	5526.44	B4D600T445A1.5	-161.767	16.499	Q	20170921.0107	/home/fast/arch/2017/2017.0921/0107.j2343p10.ms.fits
j0138m19	01:38:32.107	-19:54:45.47	2458018.954389	178	Brown_/_Kilic	3537.22	5526.26	B4D600T445A1.5	114.019	16.412	Q	20170921.0109	/home/fast/arch/2017/2017.0921/0109.j0138m19.ms.fits
J0147m16	01:47:03.996	-16:45:04.54	2458018.968602	178	Brown_/_Kilic	3537.27	5526.31	B4D600T445A1.5	120.437	13.599	Q	20170921.0111	/home/fast/arch/2017/2017.0921/0111.j0147m16.ms.fits
j0150p02	01:50:55.13	+02:52:39.57	2458018.985385	178	Brown_/_Kilic	3537.65	5526.67	B4D600T445A1.5	105.068	8.749	Q	20170921.0113	/home/fast/arch/2017/2017.0921/0113.j0150p02.ms.fits

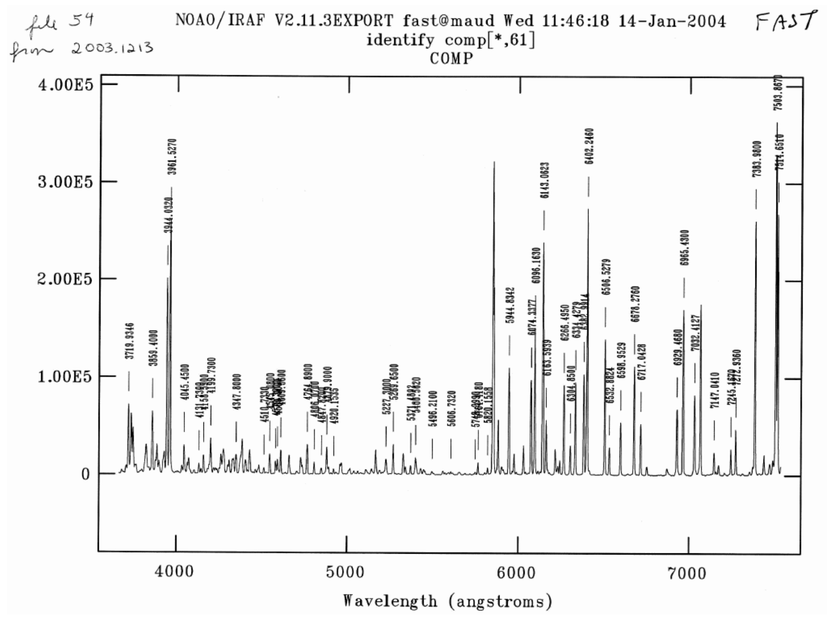
Since January 1994, the FAST Spectrograph on the 1.5-meter Tillinghast Reflector on Mt. Hopkins in Arizona has taken data on almost every clear night when the moon isn't up. Over 125,000 of those spectra of galaxies, stars, and even a few solar system objects, processed through a very slowly evolving pipeline and individually checked, are searchable and available online. We have expanded the pipeline's capabilities and are processing data in configurations that were left to the PI's to process in the past and updated the metadata of all of our spectra. We are in the process of releasing them in a VO-compatible archive. Access methods and the current version of the data reduction pipeline are described and time and spectral characteristics of the data are summarized.



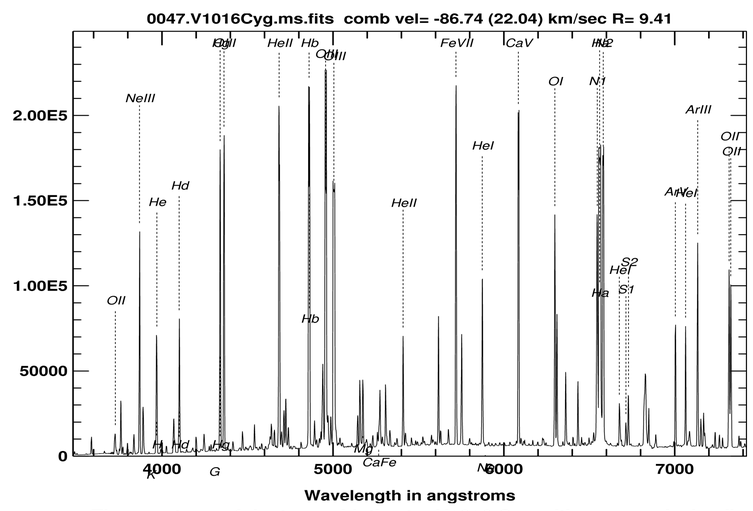
Optical schematic of the FAST spectrograph



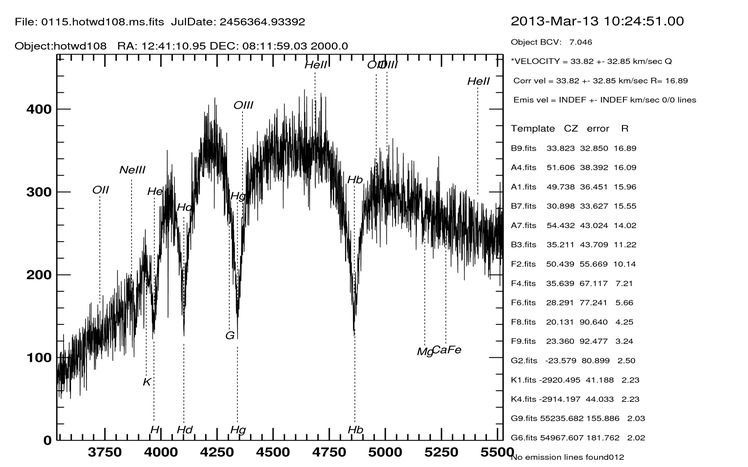
FAST on the Tillinghast 1.5-meter telescope at Whipple Observatory on Mt. Hopkins in Arizona



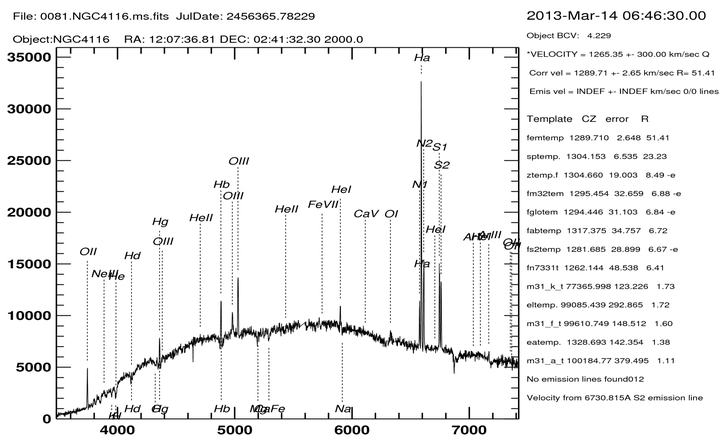
FAST HeNeAr lamp calibration 300-lpi grating spectrum



The spectrum of dusty symbiotic star V1016 Cyg with many emission lines



The spectrum of white dwarf hotwd108 show Balmer series absorption lines



Galaxy NGC4116's spectrum shows Hα triplet and S doublet emission lines

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