

"Hawaiian Starlight"

ESAC, Feb. 26, 2016

Astronomical images & timelapse cinematography

A film 12 years in the making

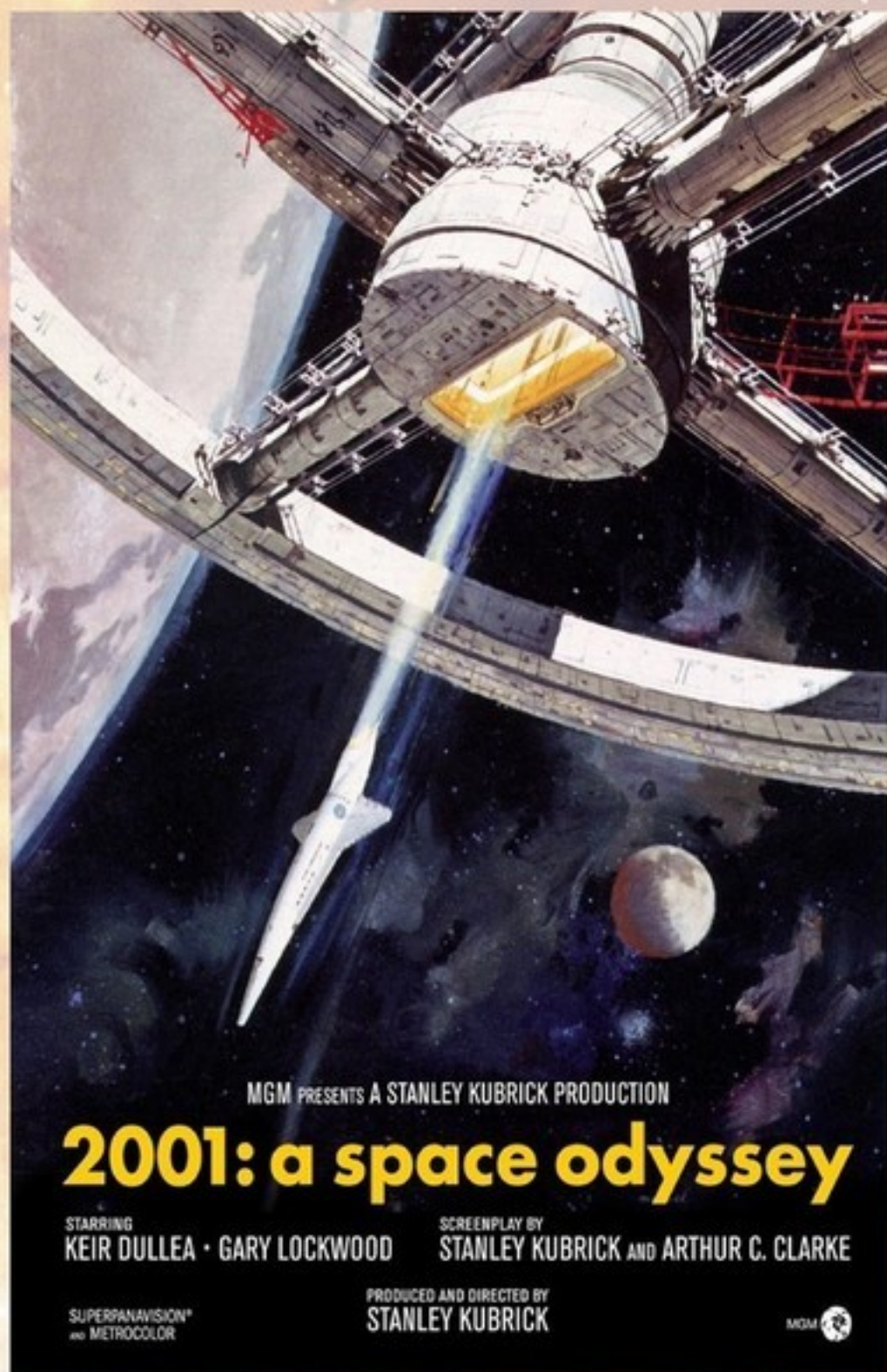
Dr. Jean-Charles Cuillandre

CEA-Saclay / Obs. de Paris / CFHT

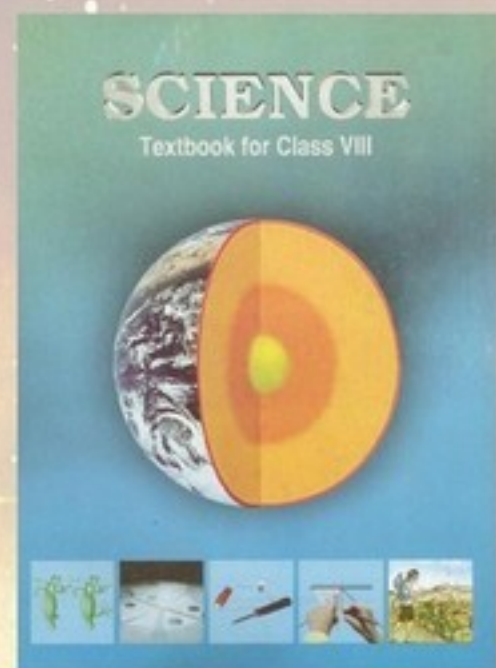
www.cfht.hawaii.edu/hs



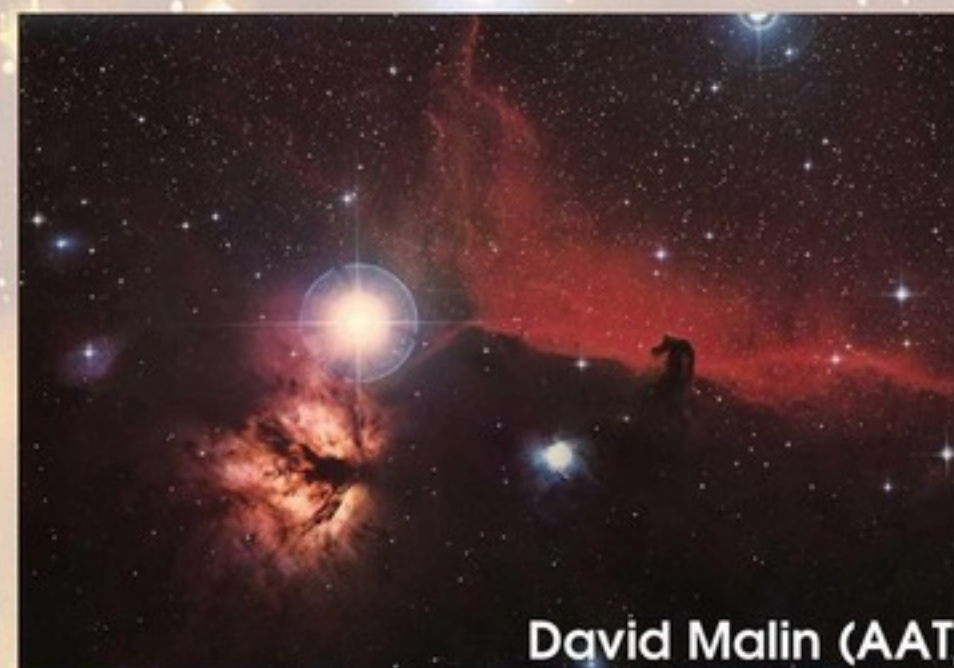
The Early Influences



Science-Fiction



Science illustrations



David Malin (AAT)

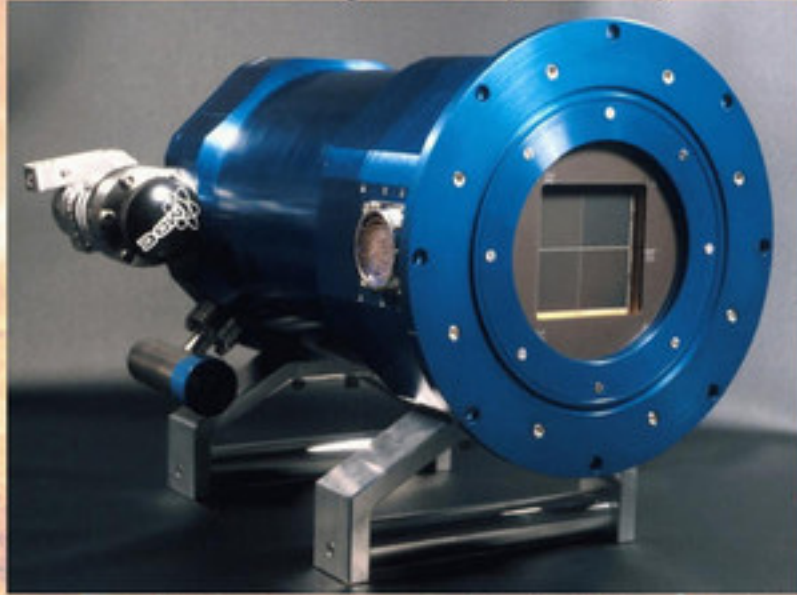


Serge Brunier (Ciel et Espace)

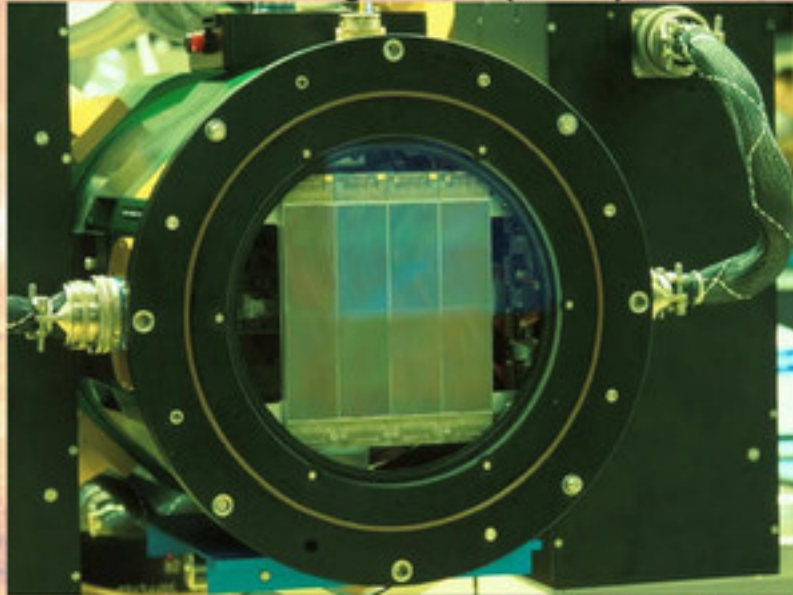
Science on Earth

Wide-field Optical Imaging at CFHT

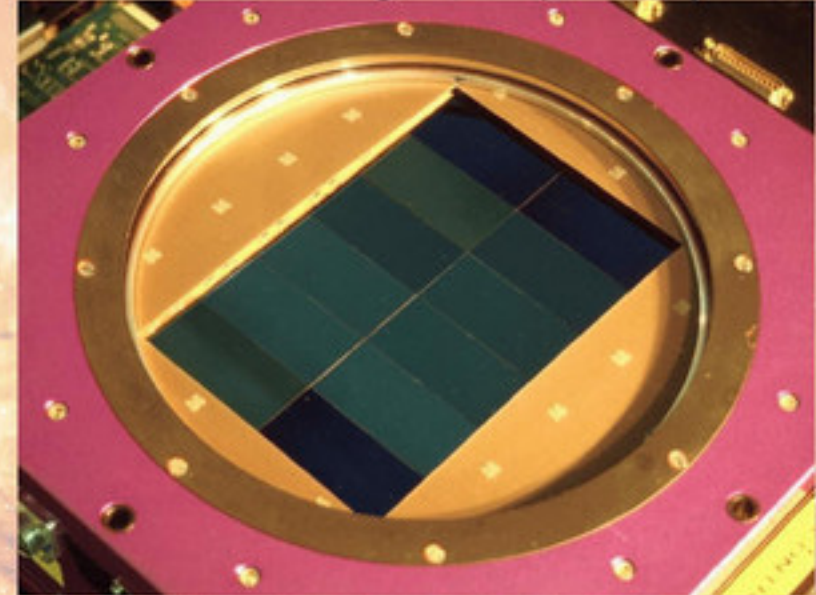
1994: 16 MegaPixels (MOCAM)



1995: 64 MegaPixels (UH8K)



1999: 100 MegaPixels (CFH12K)



2003: 350 MegaPixels (MegaCam)



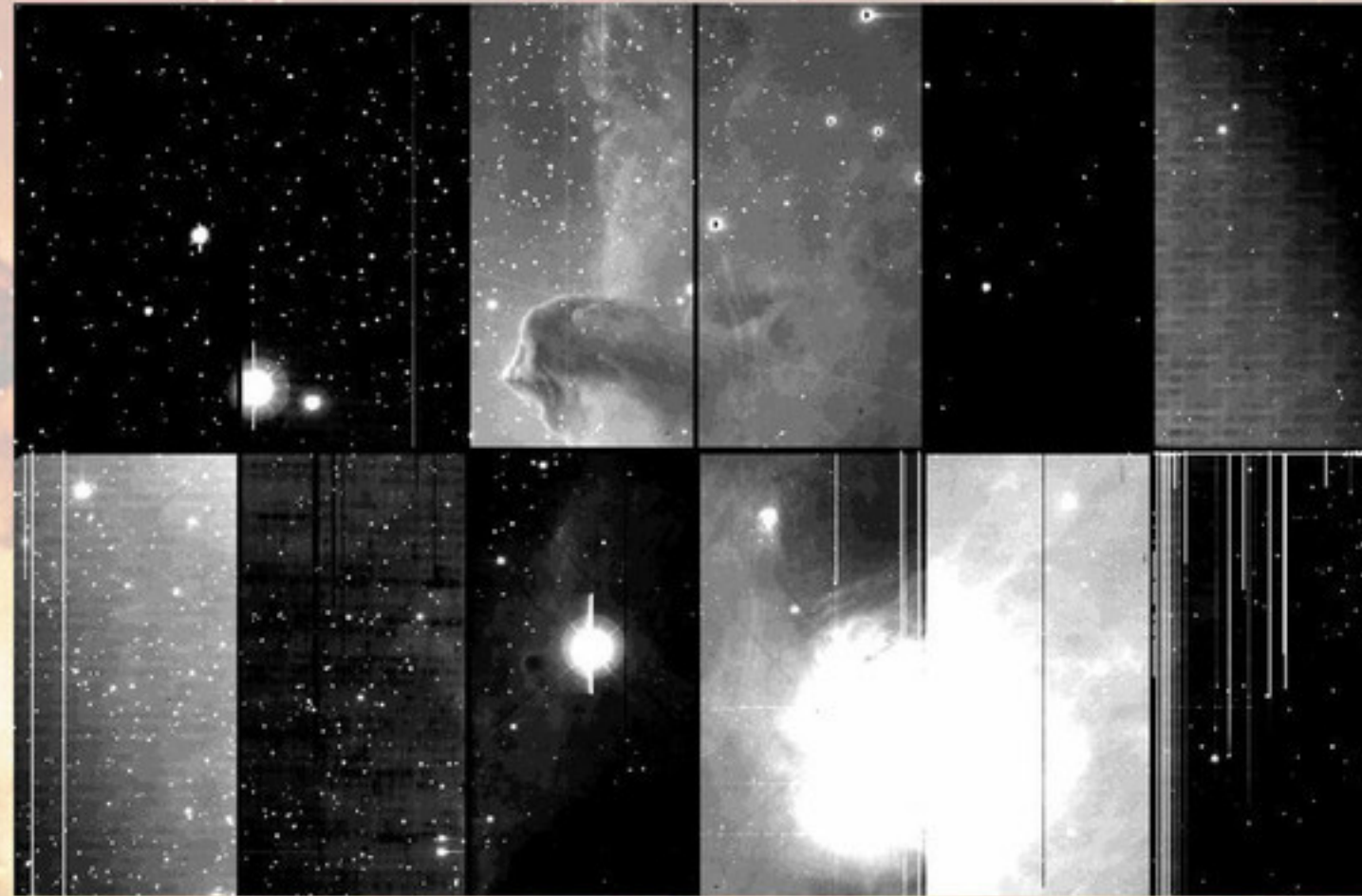
New Era in Wide Field Imaging: MegaPrime at CFHT



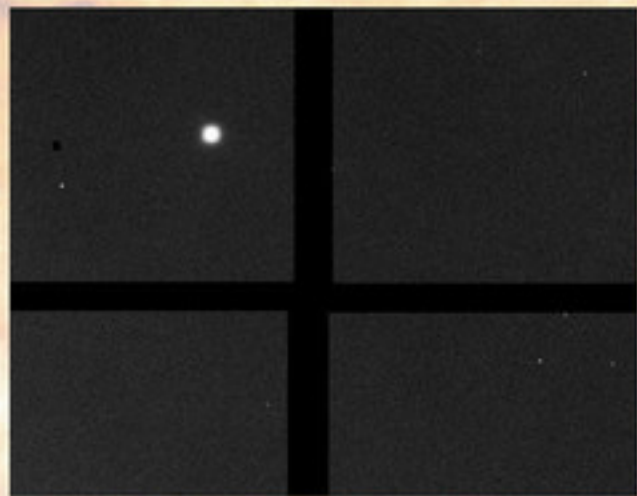
CFHT atop Mauna Kea : a clear view of the Universe



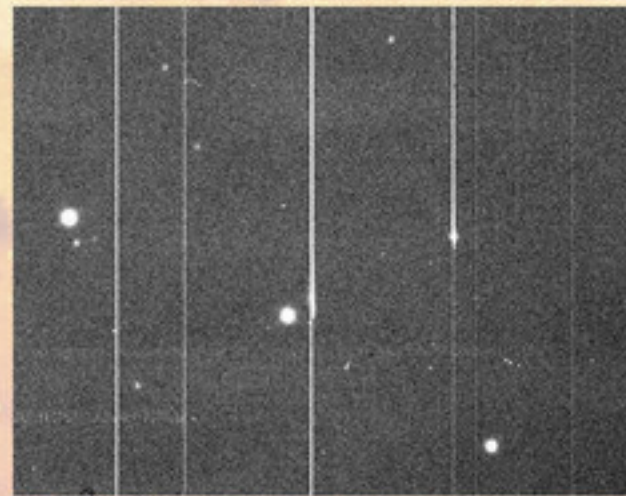
Facing the artifacts



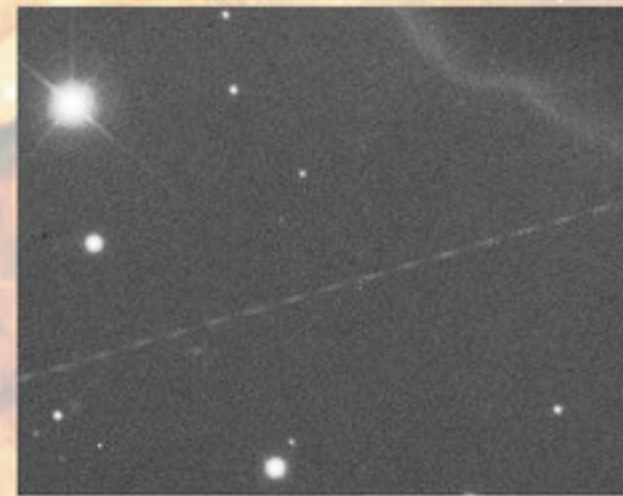
IC 434
CFH12K
V filter
3mn exposure
Raw Frame



Mosaic Gaps



CCD Cosmetic

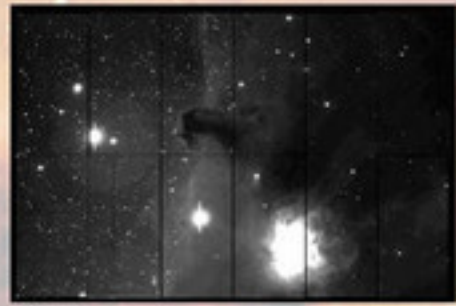


Satellite tracks

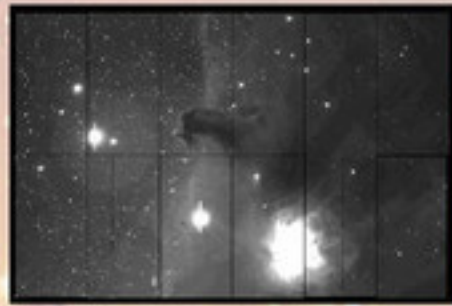


Cosmic Rays

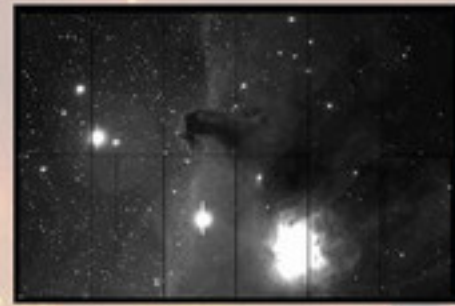
Removing the artifacts



Position 1



Position 2



Position 3



Position 4



Position 5

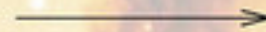


IC 434
CFH12K
V filter
~ 12600 x 8200

Tuning the framing



IC 434 – V frame



Balancing the true colors



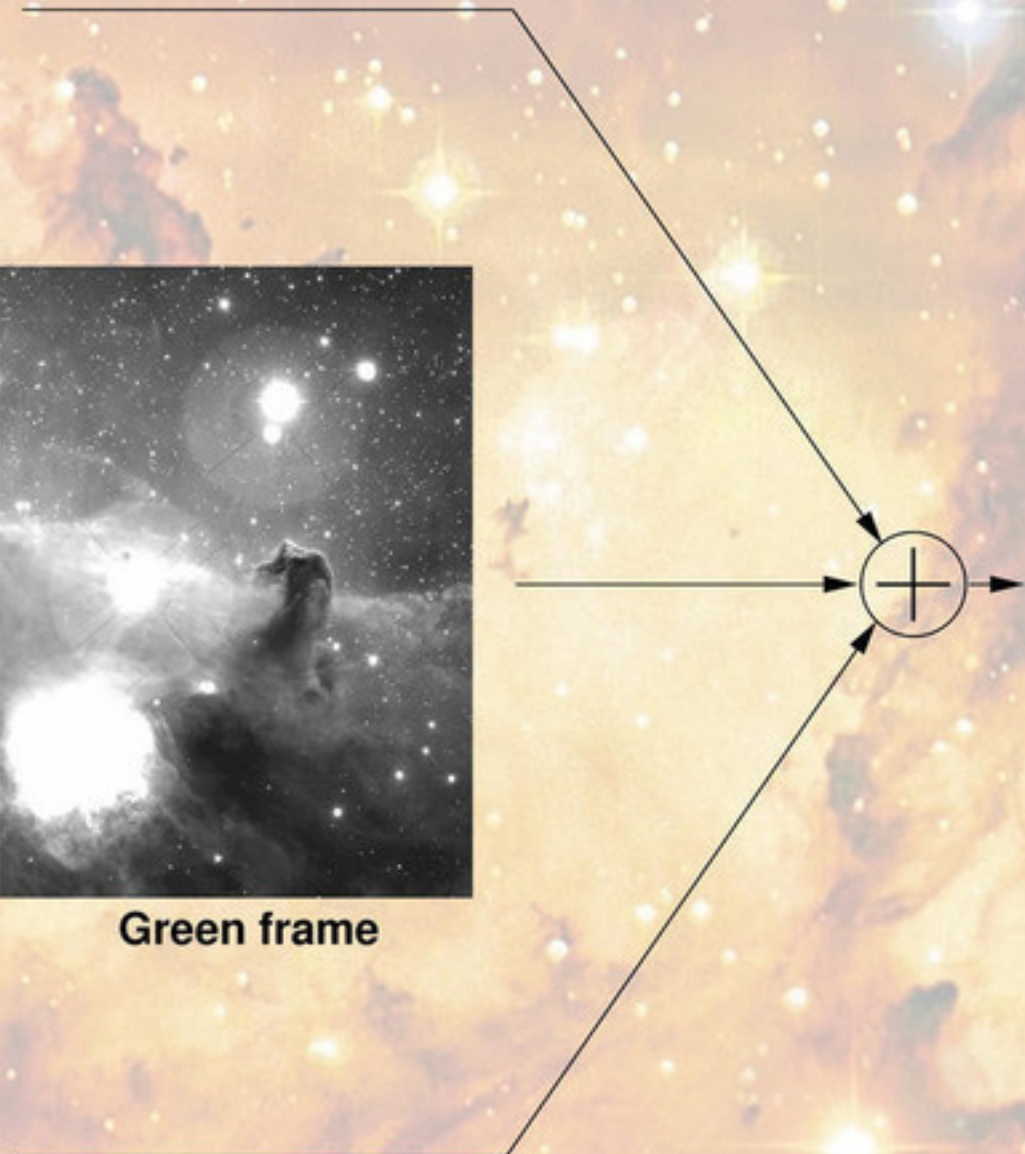
Blue frame



Green frame



Red frame



RGB true color frame

Tuning the colors and contrast

Coelum Astronomia

The final image shows the Horsehead Nebula with its natural colors (blues, greens, oranges, and reds). A star chart overlay is visible, showing the constellation Orion and the positions of the stars in the Horsehead Nebula. The image is framed by a black border with the 'Coelum Astronomia' logo in the top left and 'The Horse Nebula & IC 434by CFH' in the top right.

2002

Sun Dom Dom	Mon Lun	Tue Mar Mar	Wed Mer Mer	Thu Jeu Jeu	Fri Ven Ven	Sat Sam Sab
		1	2	3	4	5
October Ottobre	6	7	8	9	10	11
	13	14	15	16	17	18
	20	21	22	23	24	25
	27	28	29	30	31	26

The CFHT-Coelum Wall Calendar



A steady mean to build a large image collection.



Star field in the galaxy
Globular cluster, Messier 9
R.A. 17h 19m 12s
Dec. -18° 30' 58"

Image Field size: 34"x20" North →
Distance: 28,000 light yrs
Constellation: Ophiuchus



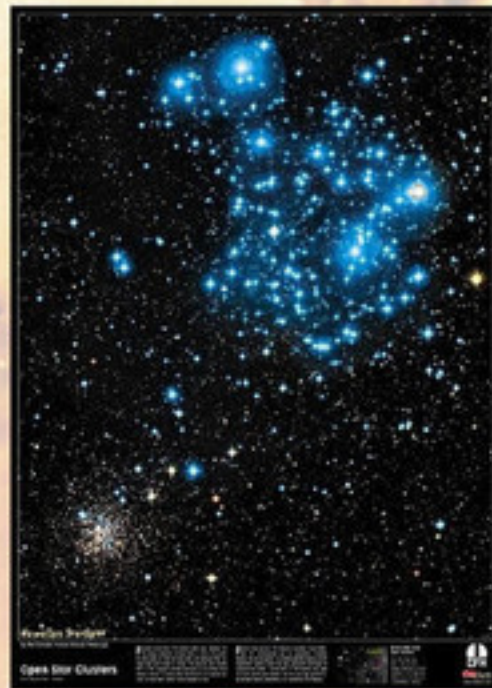
2014

Sun Dim Dom	Mon Lun Lun	Tue Mar Mar	Wed Mer Mer	Thu Jeu Gio	Fri Ven Ven	Sat Sam Sab
			1 ○	2	3	4
5	6	7	8 ▶	9	10	11
12	13	14	15	16 ●	17	18
19	20	21	22	23	24 ◀	25
26	27	28	29	30 ○	31	

CFHT Coelum

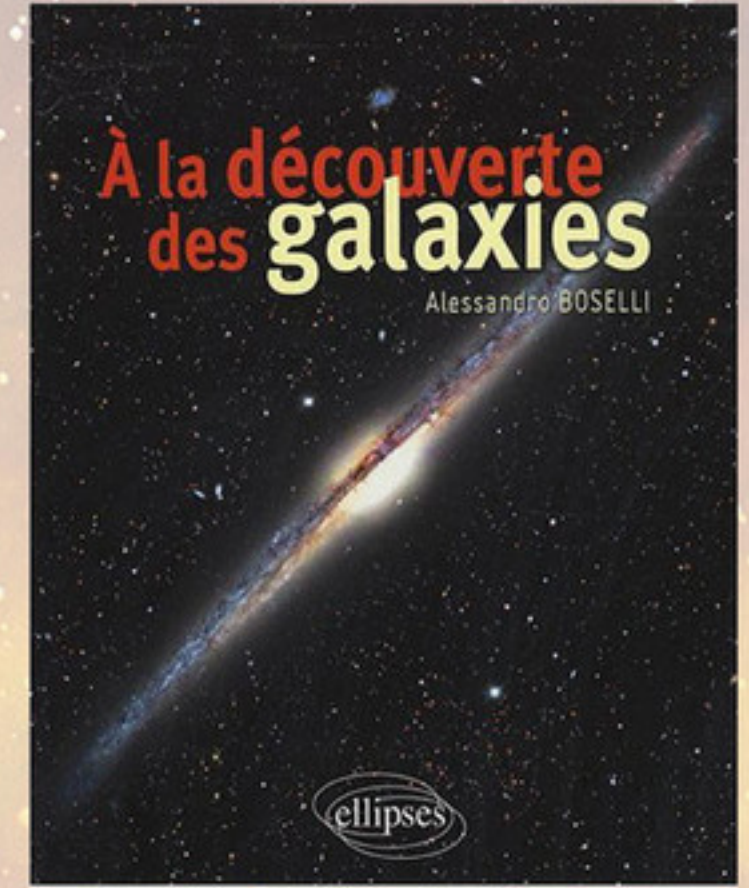
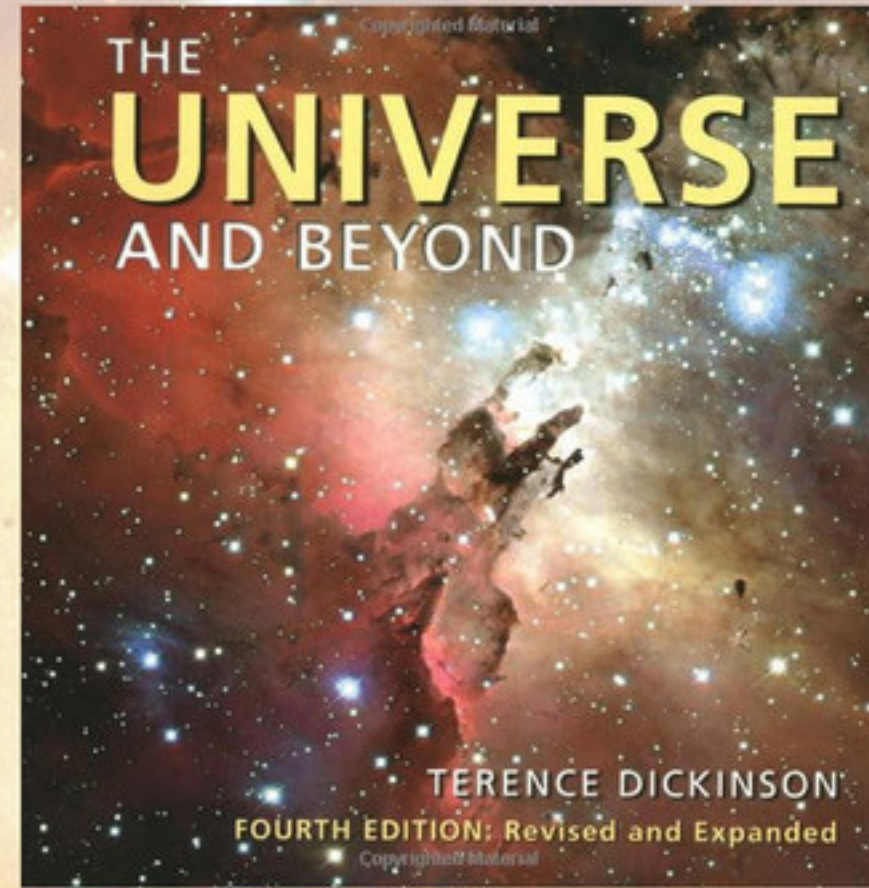
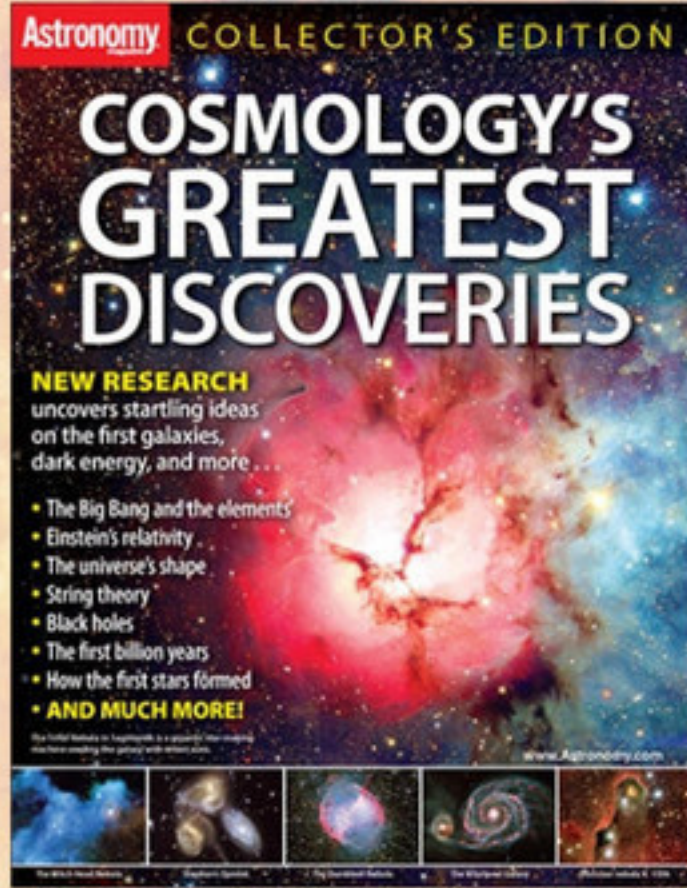
A layout refined over the years

The CFHT-Coelum Medium Posters



Hawaiian Starlight Posters – Medium: 19x27 in.

Hawaiian Starlight images in the press



An effective way to get the CFHT name out

NGC 1532-31 > Gemini Observatory/AURA | Observatoire Gemini/AURA

2009

International Year of Astronomy

Année mondiale de l'astronomie

CANADA POST	POSTES CANADA	DAY OF ISSUE	JOUR D'ÉMISSION
1641	1643	1645	1647
1675	1677	1679	1681
1709	1711	1713	1715
1743	1745	1747	1749
1777	1778	1779	1781
1809	1811	1813	1815
1843	1845	1847	1849
1877	1879	1881	1883
1911	1913	1915	1917
1945	1947	1949	1951
1979	1981	1983	1985



Lowe-Martin
Design > Keith Martin

Horsehead Nebula, Eagle Nebula >
Canada-France-Hawaii Telescope and Cœlum |
Nébuleuse de la Tête de cheval, Nébuleuse de l'Aigle >
Télescope Canada-France-Hawaï et Cœlum
Carina Nebula | Nébuleuse de la Carène > NASA



DAY OF ISSUE
JOUR D'ÉMISSION

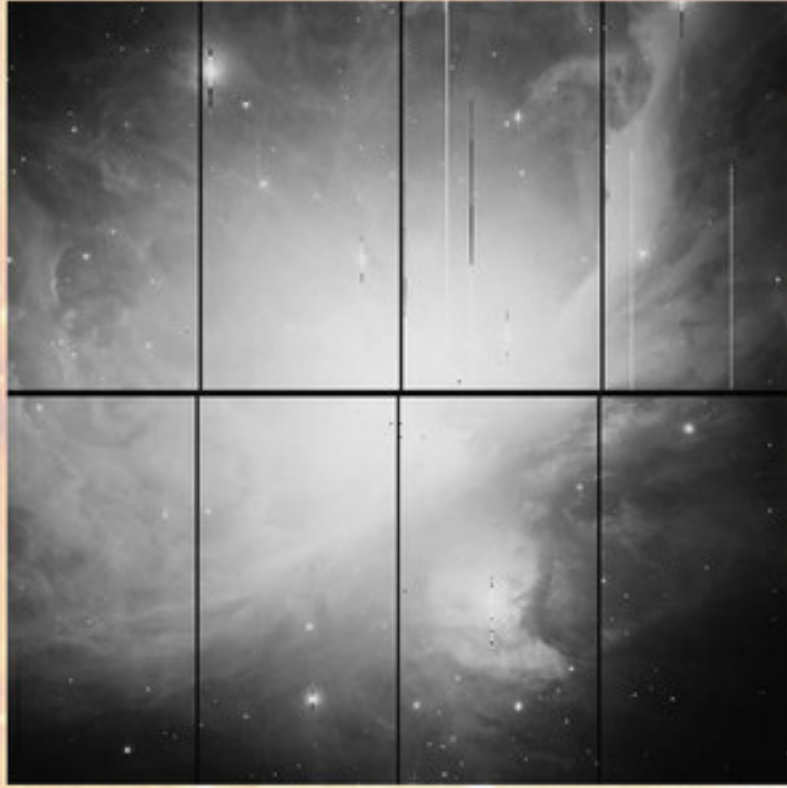
Carina Nebula | The Caterpillar
Nébuleuse de la Carène | La Chenille

International Year of Astronomy
Année mondiale de l'astronomie

SAANICH BC

The Orion Nebula through the years

MegaCam - 2009



UH8K - 1995



CFH12K - 2003



BONUS! Sky Guide 2011

16 pages of calendars, eclipses, meteor showers, planets, comets, all you need to know

What is the Sun
made of? p. 26



December 2010

Astronomy

The world's best-selling astronomy magazine

NEW RESEARCH

How stars form

Stars change from cold gas to blazing hot fireballs
— here's how they do it p. 32

See the nearest stars p. 52

How 5 doomed missions
triumphed in the end p. 44

The Orion Nebula (M42) ranks among the biggest and brightest stellar nurseries in our galaxy. In this photo, luminous gas hides most of the thousands of newborn stars.

www.Astronomy.com

PLUS!

Bob Berman on this month's lunar eclipse p. 16

PlaneWave's hot new imaging scope p. 56

Astronomy's editors answer your questions p. 50



BUNGIE
Microsoft
game studios

PROPERTY OF MICROSOFT



Capturing timelapses one still at a time



2001–2003: laptop control + USB download

Time interval > 10s



2003–2013: wired control + internal memory

Time interval > 1s

Compact cameras and digital SLRs

Compact Cameras



Olympus C3040Z
2001–2002
3 Mpx
CCD
6 fr/mn max
(R x 240)
52,000 / 14 Gb



Olympus C5050Z
2003
5 Mpx
CCD
12 fr/min max
(R x 120)
26,000 / 7 Gb



Olympus C8080Z
2004–2007
8 Mpx
CCD
15 fr/mn max
(R x 96)
23,000 / 16 Gb

Digital SLRs



Canon D60
2003–2004
6 Mpx
CMOS
30 fr/mn max
(R x 48)
91,000 / 41 Gb



Canon 20D
2005–2009
8 Mpx
CMOS
60 fr/mn max
(R x 24)
38,000 / 40 Gb



Canon 5DMII
2009–2013
21 Mpx
CMOS
60 fr/mn max
(R x 24)
177,000 / 552,000 Gb

Quality glass



17–35 mm f/2.8



28–75 mm f/2.8



50 mm f/1.4



70–200 mm f/4



24–70 mm f/2.8

2003–2009

2009–2013



Gain in resolution

A not user-friendly text based video tool

```
chveta
#
# Background for intro text
pan reset
pan /usr/share/backgrounds/Background1900p.fig
vid /usr/share/backgrounds/BackgroundThemeDark.jpg fade=0.0 to fadein=gamma,0.6s fadeout=black,1s overlap=6s
pan reset
txt reset black
txt y=50c h=50c align=center font=times "Technical advances in video games scores"
vid txt 5.7s fadein=black,1s fadeout=gamma,1s
vid black 0.3s

# Music for intro text
and /usr/share/sounds/17_The_Raw 0 0 "end_time" 2 vol 1.0

#
# Interview still
length=30s
pan /usr/share/backgrounds/Background1900p.fig
vid /usr/share/backgrounds/Video-CanonSDM11_110701_1711_000.jpg fade=0.0 to fadein=gamma,0.6s fadeout=black,0.1s

# Interview sound
and /usr/share/sounds/97_Adaptive_Basic_Declipped.stereo.wav start=11.0s len=30s vol=1.0 fadein=0.1s fadeout=0.1s

# Fill in with silence when needed
# and /usr/share/sounds/17_The_Raw len="end_time" vol=0.0

function Runq_Interview_796 () {
  echo " * Runq Interview 796 - Audio director"

  #
  # Background for intro text
  pan reset
  pan /usr/share/backgrounds/Background1900p.fig
  vid /usr/share/backgrounds/BackgroundThemeDark.jpg fade=0.0 to fadein=gamma,0.6s fadeout=black,1s overlap=6s
  pan reset
  txt reset black
  txt y=50c h=50c align=center font=times "Audio director"
  vid txt 5.7s fadein=black,1s fadeout=gamma,1s
  vid black 0.3s

  # Music for intro text
  and /usr/share/sounds/17_The_Raw 0 0 "end_time" 2 vol 1.0

  #
  # Interview still
  length=30s
  pan /usr/share/backgrounds/Background1900p.fig
  vid /usr/share/backgrounds/Video-CanonSDM11_110701_1711_000.jpg fade=0.0 to fadein=gamma,0.6s fadeout=black,0.1s

  # Interview sound
  and /usr/share/sounds/97_Audio_Director_Hale_Declipped_Declipped.stereo.wav start=13.00s len=520.7 vol=1.0 fadein=0.1s fadeout=0.1s
  and /usr/share/sounds/97_Audio_Director_Hale_Declipped_Declipped.stereo.wav start=139.5s len=67.6s vol=1.0 fadein=0.1s fadeout=0.1s
  and /usr/share/sounds/97_Audio_Director_Hale_Declipped_Declipped.stereo.wav start=202.3s len=64.7s vol=1.0 fadein=0.1s fadeout=0.1s
  and /usr/share/sounds/97_Audio_Director_Hale_Declipped_Declipped.stereo.wav start=271.0s len=142s vol=1.0 fadein=0.1s fadeout=0.1s

  # Fill in with silence when needed
  # and /usr/share/sounds/17_The_Raw len="end_time" vol=0.0
}

"HawaiianStarlight-ScenicFilm.script" (converted) 10308L, 4906/90 written
1702,9
```

Video&sound editing: a compiled language approach

```
April 29 22:09:19 - root - ./HawaiianStarlight-ScenicFilm.script
HawaiianStarlight-2011-Preview-WS-tnp/00-and01.raw
Have file will get rate converted from 40000 to 44100 Hz
# Reached end of ./HawaiianStarlight-ScenicFilm.script
# Beginning MPEG2 (H264) encoding
Selected gnu toolset.

# Encoding Part 0 (3000)
mpeg2enc: List length: 10176, 10025 projected
mpeg2enc: Encoding MPEG-2 video to HawaianStarlight-2011-Preview-WS-tnp/00-tnp.n2v
mpeg2enc: Horizontal size: 360 pel
mpeg2enc: Vertical size: 240 pel
mpeg2enc: Aspect ratio code: 1 = 1:1 pixels
mpeg2enc: Frame rate code: 3 = 25.0 (PAL/SECAM 50/60 / converted FILM)
mpeg2enc: Bitrate: 360 Kbit/s
mpeg2enc: Quality factor: 2 (Quantisation = 2) (1=best, 31=worst)
mpeg2enc: Field order for input: none/progressive
mpeg2enc: Sequence unlimited length
mpeg2enc: Search radius: 16
mpeg2enc: DualPrime: no
mpeg2enc: Using one-pass rate controller
file HawaianStarlight-2011-Preview-WS quality -0 list length 10176 Pipeline is running
*
decoder: 01583 Video-CanonSDM11_110701_1711_000.jpg, size 1920x1080 (1232)
panner: 01583 static, x=90.5 y=540.9 w=2063.9 rot=0.0
deflicker: 01494 pass-through (use QUALITY>=1 to enable)
persist: 01483 pass-through
fader: 01482 01332 pass-through

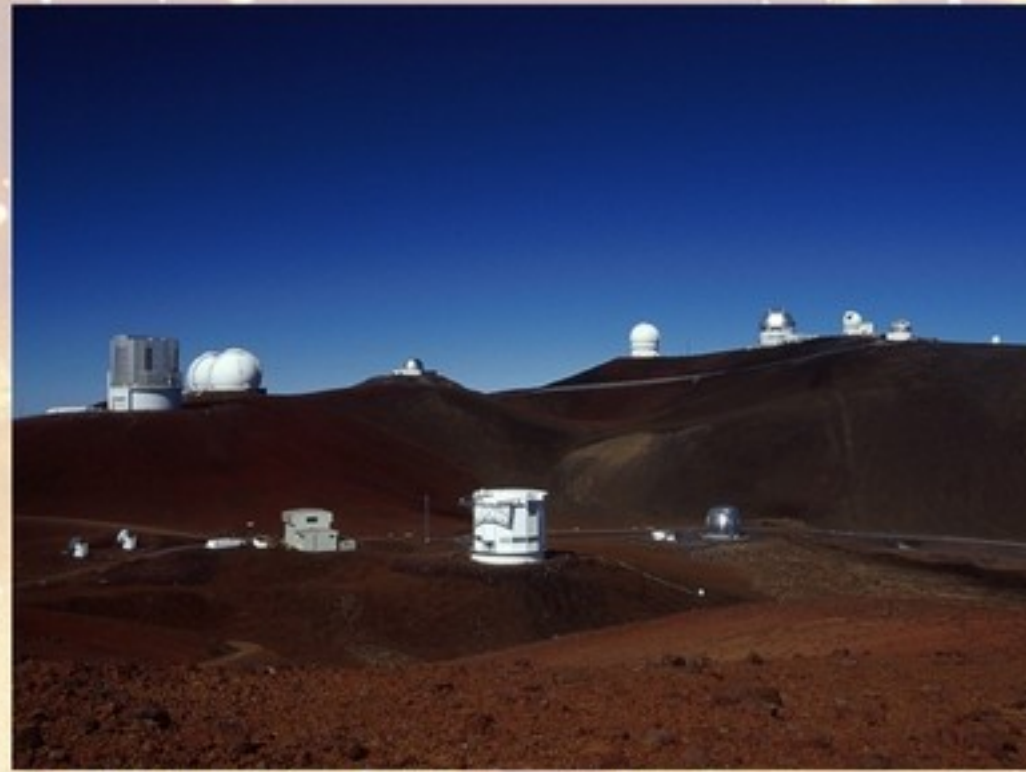
mpeg2enc: Frame 01324 F quant=2.54 sum act=36770.76831
```

Multi-threading video&audio pipeline

Mauna Kea's magic through timelapse



The CFHT atop Mauna Kea



The Mauna Kea observatories



Mauna Kea at its most spectacular



Hints of Hawai'i (Big Island)

Martin O'Donnell



BUNGiE

Hawaiian Starlight, the film

