### The Royal Observatory Edinburgh: Astronomy past, present, and future





#### John Peacock University of Edinburgh



## The start of astronomy in Edinburgh



- 1736: Colin Maclaurin collects funds for a university observatory
- 1776: Calton Hill observatory designed (Robert Adam)
- 1785: Regius Chair of Astronomy established (Robert Blair)
- 1818: New building by William Henry Playfair
- 1822: Royal Observatory title from George IV
- 1834: Thomas Henderson first Astronomer Royal for Scotland
- 1846: Charles Piazzi Smyth 2<sup>nd</sup> Astronomer Royal
- 1847: Funding crisis and government takeover
- 1888: Closure?

## **Calton Hill Observatory**





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## **Thomas Henderson**







1798 - 1844

First to measure parallax – second to publish...



## **Charles Piazzi Smyth**





1819 – 1900







Modern views: foreign mountain sites

But also pyramids...

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## Crawford





#### Dunecht observatory 1872-1888

James Ludovic Lindsay 26<sup>th</sup> Earl of Crawford (1847–1913)

Scotland's best-equipped observatory





## **The Crawford collection**





15000 books on astronomy, back to 1200. An irresistible bribe





7 hills surveyed by Ralph Copeland. Blackford hill quite distant from city, and close to railway

New building designed by Walter Wood Robertson; constructed 1892-94















#### <u>36 INCH REFLECTOR</u> <u>THE ROYAL OBSERVATORY EDINBURGH</u> SIR HOWARD GRUBB, PARSONS & COMPANY.



## **New toys**

1928: 36-inch telescope (still Scotland's largest)

work on spectral
classification of stars up
till 1960s

(WOBAFGKMRNS...)

## **Hermann Bruck**



Director 1957 - 1975

Rode the wave of 1960s expansion:

- expanded staff from 12 to >100
- started undergraduate astronomy degree

Many far-sighted initiatives







#### Australia: UK Schmidt telescope







A complete photographic survey of the southern sky



## The transition to digital



Pixel data from COSMOS (1970 – 1990) and SuperCOSMOS (1990 – 2004)





## All-sky galaxies: UKST + POSS2





## **The Anglo-Australian Telescope**









2dF Galaxy Redshift Survey: 220,000 redshifts



## Hawaii: UK Infrared Telescope

INIV

#### 1978 – 2012





Trapezium Cluster • Orion Nebula WFPC2 • Hubble Space Telescope • NICMOS

1 – 10 microns: piercing the dust

## Hawaii: UK Infrared Telescope







## Hawaii: James Clerk Maxwell Telescope (1985 – 2015?)



## Seeing the dust





Wavelengths just below 1mm see dust heated by invisible young stars

#### SCUBA2 Cosmology Legacy Survey Cosmic history of dust-enshrouded star formation

#### SCUBA2 Camera built in Edinburgh

Now on James Clerk Maxwell Telescope in Hawaii

World's first CCD-like sub-millimetre camera

SCUBA2 survey led by Edinburgh





#### SCUBA2 Cosmology Legacy Survey Cosmic history of dust-enshrouded star formation



Largest and deepest image of the sky at 450 microns





## **Observatory Wars 1991-97**





1991: Did the UK need two National Observatories? ROE and the RGO (Royal Greenwich Observatory – in Cambridge)

1997 Decision: Close RGO and found UK Astronomy Technology Centre at Edinburgh

## **2004: The Crawford Laboratory**





## **2004: The Crawford Laboratory**





## **2010: maintaining the old ROE**











#### Edinburgh Astronomy Today: ROE = IfA + UKATC + VC





Institute for Astronomy: 16 faculty; 26 postdocs; 30 postgrads UK Astronomy Technology Centre: 6 instrument scientists; 60 engineers Visitor Centre: 4 outreach staff (+ postgrad assistance)

## UKATC + IfA: scientific synergy





UKATC - Britain's National Observatory builds innovative instrumentation for all UK astronomers (e.g. SCUBA2 submm camera)

 placement in academic research environment critical in generating new ideas

**1997:** Decision to site UKATC at Edinburgh based on staff skills but especially on close relationship with IfA. ~ 8 staff transfer to IfA, founding Wide-Field Astronomy Unit

Relationship benefits both sides: stimulus to think about new instrumentation needs; range of research; access to PhD students; training in instrumentation



## Survey astronomy at Edinburgh



- Wide-field astronomy unit science databases:
  - All-sky Schmidt optical legacy surveys
  - Large-area current IR surveys (WFCAM, VISTA)
  - Next generation CCD surveys
  - Virtual Observatory and e-science tools





## **Scientific outlook**



• Probing the nature of dark matter and dark energy

- Aims: Understanding the formation of galaxies and stars
  - Using ATC-related facilities (40m ELT; James Webb ST)



# 2009 THES: Scotland leads the world in 'Space Science'



	Country	Papers	Citations	Impact
1	Scotland	2,319	52,710	22.73
2	Israel	1,570	31,822	20.27
3	Canada	5,729	111,737	19.50
4	Chile	3,322	62,653	18.86
5	United States	55,539	1,039,395	18.71
6	The Netherlands	5,827	108,303	18.59
7	Denmark	1,511	27,991	18.52
8	England	15,968	293,401	18.37
9	Australia	4,990	89,928	18.02
10	Switzerland	2,959	51,649	17.45
11	Germany	17,572	304,158	17.31
12	Italy	11,944	186,411	15.61
13	Sweden	2,147	32,765	15.26
14	France	13,977	203,653	14.57
15	Spain	7,017	96,634	13.77
16	Japan	8,797	117,883	13.40
17	Poland	2,683	35,198	13.12
18	Mexico	2,376	28,985	12.20
19	Russia	8,567	59,669	6.96
20	China	6,022	36,777	6.11

 ROE astronomers account for 60% of all Scottish citations



## The future







#### **KMOS**

















#### Dark matter dominates ordinary by 5:1

#### Seen most directly and robustly by gravitational lensing



### **ESA's Euclid Dark Energy Mission**

- To map the 3-D structure of Dark Matter, probe the nature of Dark Energy and test Einstein Gravity
- Edinburgh leads Euclid's gravitational lensing probe of dark matter.
- Edinburgh hosts the UK Science Data Centre for Euclid analysis.
- Launch due in 2020.



## **The Higgs Centre for innovation**





New building hoping to start construction spring 2015

 main aim is to house
'incubators': small hightech companies who can benefit from expertise of
IfA academics and
UKATC engineers

## The outlook for ROE



- Prepare for leading role in major facilities of 2020s
  - Euclid
  - JWST
  - ELT
- University research continues to benefit from UKATC instrumentation
- Grow role as data centre
- In balance with theory
  - Including Edinburgh's strength in supercomputing

