Helas Outreach

A deconstruction of

“Songs of the Stars”
“Begin at the beginning,”

the King said, very gravely,

“and then go on
till you come to the end:
then stop.”
“The beginning”
Talk
to your audience –
make contact
Opening your talk - Humour

- Be very careful with jokes!
- Anecdotes
- True stories
- Self-deprecation
Podiums are poison
Lecterns are lethal

- Do not hide behind the equipment –
  no barriers between you and them

- Get out front

- Move about some
Timing – the beginning

Never trust the equipment

Check it out well before your talk
What to do if there are problems

- Let someone else sort it out

- You talk to your audience while things get fixed
  - Tell a story
  - Start your talk
  - It is a good idea to have back-up talk that you can give with no presentation materials

- The audience holds you responsible
“Going on”: Your presentation

The hook!

- The start is where you catch their attention
- It is the most important time in your talk
- Have an idea to hang your talk on
  - You will come back to that idea at the end
Songs of the stars: the real Music of the Spheres
At first sight it would seem that the deep interior of the sun and stars is less accessible to scientific investigation than any other region of the universe.
Our telescopes may probe farther and farther into the depths of space; but how can we ever obtain certain knowledge of that which is hidden behind substantial barriers?
What appliance can pierce through the outer layers of a star and test the conditions within?
Asteroseismology
Always bring your ideas “down to Earth”

- Relate to everyday life
- Relate to everyday knowledge
- This is more difficult with young people because they have little general knowledge
The Music of the Spheres

Pythagoras of Samos
(c.569 - 475 BC)

Plato said that a siren sits on each planet, who carols a most sweet song, agreeing to the motion of her own particular planet, but harmonising with all the others.
The Music of the Spheres

Pythagoras of Samos
(c.569 - 475 BC)

Johannes Kepler
(1571 – 1630)

2:1 ratio

Terra

Jupiter

Saturnus
There’s not the smallest orb which thou beholdest but in his motion like an angel sings Still quiring to the young-eyed cherubims
(Merchant of Venice, v. 1)
Seeing with sound
Assume no knowledge

- Your audience is intelligent
- Some in your audience are highly educated
- Some in your audience know more than you do about some topics of your talk
- Give the basics, but do not talk down to them
Sound is a pressure wave

- More frequent collisions = faster sound speed
  - Higher temperature = faster sound speed
  - Lighter gases = faster sound speed
The range of human hearing

- 20 Hz to 20,000 Hz

1 cycle per second = 1 Hertz = 1 Hz

- Bats echo-locate at 50,000 Hz
The range of human hearing

- 20 Hz to 20,000 Hz

1 cycle per second = 1 Hertz = 1 Hz

- Elephants “rumble” at 10 Hz

- Blue Whales “sing” at 12-200 Hz
12-200 Hz songs

16-25 Hz buzzes, rasps
The range of human hearing

- 20 Hz to 20,000 Hz

- Galaxies have sound waves with periods of once per 200 million years!
1D oscillations

Fundamental

First overtone

Second overtone

nodes

modes
1D oscillations: The baseball bat
The cricket bat

The “sweet spot”
Interference
Harmonics
Harmonics
2D oscillation – drums
the radial modes

fundamental mode  1\textsuperscript{st}-overtone mode  2\textsuperscript{nd}-overtone mode
2D oscillation – drums
the non-radial modes

dipole mode
quadrupole mode
first overtone dipole mode
2D oscillations – drums

Figures 1a to 1f (top left to bottom right): Six of the simpler modes of a flat circular plate.
2D oscillations
2D dipole oscillations in the Tacoma Bridge disaster
Listening to the songs of the stars
3D oscillations – stars
radial modes
Modes in stars are not harmonic
Cepheid variables

Cepheid Horn by Zoltan Kollath, Konkoly Observatory, Budapest
Cute animations

- Scientific animations are helpful
- Irrelevant animations distract your audience
Cepheid variables

Cepheid Horn by Zoltan Kollath, Konkoly Observatory, Budapest
Cepheid variables

- Henrietta Leavitt (1868-1921)
- Discovered in 1908 the Period-Luminosity relation for Cepheids in the LMC

“It is worthy of notice that ... the brighter variables have the longer periods.” (Leavitt 1908)
Henrietta Leavitt’s PL discovery
1912

brighter

magnitude

Period in days

Fig. 1.

Fig. 2.
The proof that “spiral nebulae” are galaxies - 1923

Edwin Hubble

A Cepheid in Andromeda
Doppler shift
Doppler shift – shock waves
Doppler shift – shock waves
Bow Shock Around LL Orionis
Using Doppler Shift to measure velocity
Using Doppler Shift to measure velocity
Expansion of the Universe

10000 km/s

1000 km/s

Fainter (so farther)

Edwin Hubble and Milton Humason, 1931, Astrophysical Journal, 74, 43
3D in stars

Radial modes
3D in stars

Non-radial modes: The dipole mode

$l=1, m=0$
HR 3831 – IM Velorum
The oblique pulsation of HR 3831
The sun
• TRACE 171A pass band; 1 MK plasma; 1999 November 6
How does asteroseismology work?
3D in stars

Non-radial modes: quadrupole modes

$l=2, m=0$

$l=2, m=2$
Rotation of the sun
Globular cluster M4

BPM 37093 “Bruce”
roAp stars - HR 1217

like nothing you have ever seen

dipole(-like)

new mode

strange doublet
Radial Velocity

HD137949 PrIII 5284

RV m/s

0  1  2
hours

Observed Velocity Variation of mu Arae
(3.6m/HARPS, 1.2m Swiss/CORALIE, AAT/UCLES)

ESO PR Photo 25b/04 (25 August 2004) © European Southern Observatory
Velocity Variation of \( \mu \) Arae Observed by HARPS (3.6m/HARPS)

ESO PR Photo 25c/04 (25 August 2004) © European Southern Observatory
HD160691 $P=7.5\,\text{d} \ K=3.8\,\text{m/s}$

$\text{kms}^{-1}$

$\text{BJD} - 2453160$
Ground-based detections of stellar oscillations

Sun (BiSON)
Ground-based detections of stellar oscillations


α Cen A

α Centauri
The Red Giant Star $\xi$ Hydrae

Oscillation Frequencies in the Giant Star xi Hya

ESO PR Photo 13a/02 (15 May 2002)
RR Lyrae stars in the globular cluster M3

Zoltan Kollath – Konkoly Observatory, Budapest
What appliance can pierce through the outer layers of a star and test the conditions within?

Asteroseismology: the Songs of the stars
Stellar acoustics as input for music composition

Zoltán Kolláth
Konkoly Observatory, Budapest, Hungary

Jenő Keuler
Institute for Musicology, Budapest, Hungary

http://www.konkoly.hu/staff/kollath/stellarmusic/
Some details

- Think about your audience

- Can they read your slides?
  - Have you left them enough time?
  - Have you put too much in?
  - Do they understand your graphs?

- Keep your eye on them to see how they are responding to you!
Bad!

Graphs
Good

Graphs

Observed Velocity Variation of mu Arae
(3.6m/HARPS, 1.2m Swiss/CORALIE, AAT/UCLES)
Can they read your slides?

- If not, describe them
- If you do not want them to read it, then do not put it in!
- Be careful of too much detail
Words on slides

- Notes for you?

- Notes for them?

Both! –but mostly for them

- Make sure they are useful
Can they hear you?

- A microphone is your friend
- Do not be frightened of it
- It does not bite!
- Listen to yourself – how do you sound to them?
“and then go on
till you come to the end”

- Remember:

  You are telling a story

  - Make sure there are interesting points to stitch together the details
  - Make sure there is something for everyone – put in some advanced ideas, too
Managing your time

- Have more than one ending

- Put less on slides
  - You can adjust how much you say
  - You cannot adjust the slides

- Be aware of the time
Going overtime

Do not do it! – It is a sin

- Your audience will stop listening to you
- Everyone has plans following your talk
A polished presentation

- Does it matter?

- Yes!

- It says that you have taken a lot of time because this audience is important

- Audiences appreciate that
Don’t point out small faults in your talk

- Your audience will not usually notice

- Do not bring faults to their attention

Prepare:

but

Do not apologise for not preparing
Disaster strikes

What to do?

Talk to your audience!
Question time

Be patient for the first few questions

Hecklers

Never attack a member of the audience!

You will threaten them all

Be calm

Be reasonable
The “form” of your story

Typical science talk

Novel or play
“Begin at the beginning,”

the King said, very gravely,

“and then go on
till you come to the end:
then stop.”