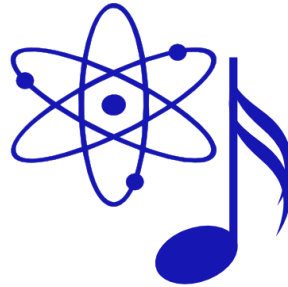


Session 9
Revision / Reflection
Gavin Bell



Science of Music



Today's session

- **Form 4 groups please**
- **The concert: a reminder**
 - *Yorkston-Thorne-Khan & Laura Moody*
 - Reflections on the course
 - **Sarangi and Nyckelharpa**
 - “Laura Moody Super Quiz!” – spectrograms
- **Example exam question**
- **Topic: 2 dimensional oscillators**
 - MATLAB, violin, Chladni plates, modes of oscillation
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Yorkston-Thorne-Khan



Laura Moody





Reflections

Week	Date	Session Title	Physics Convenor	Notes
1	15 Jan.	Thank you for sharing...	Gavin Bell	includes in-class assessment
2	22 Jan.	Fundamentals of sound	Gavin Bell	
3	29 Jan.	Scales and tuning	Paul Harrison	
4	5 Feb.	Perception of sound and music	Michael Pounds	moodle test on 2 & 3
5	12 Feb.	Acoustic instruments	Sue Burrows	
6	19 Feb.	The human voice	Rudolf Roemer	moodle test on 4 & 5
7	26 Feb.	Music in the environment	Rachel Edwards	
8	4 March	Electronic music	Gavin Bell	moodle test on 6 & 7
9	11 March	Revision & Reflections	Gavin Bell	
10	18 March	Project presentations practice	Sue Burrows	peer assessment



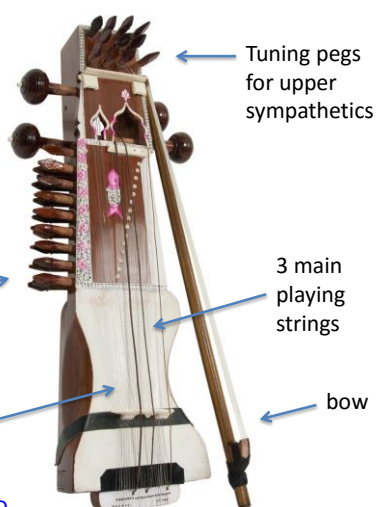
Khan

Sarangi

- “3-box” stringed instrument
- Bowed, 3 main strings
- Drone string
- Up to 36 sympathetic strings

Tuning pegs
for side
sympathetics

Usually 4th
drone string



Tuning pegs
for upper
sympathetics

3 main
playing
strings

bow

https://www.youtube.com/watch?v=l60XK8whr_Q



Yorkston

Nyckelharpa

- Traditional Swedish instrument
- 3 melody strings played with short bow
- Drone string
- 12 sympathetic strings



<https://www.youtube.com/watch?v=EK88Vf6pTIU>

Keys operate "tangents" which stop the melody strings to select notes



Generator / resonator / radiator

MT gives these components as essentials of any instrument.

1D? 2D? 3D?





Laura Moody Super Quiz! 1

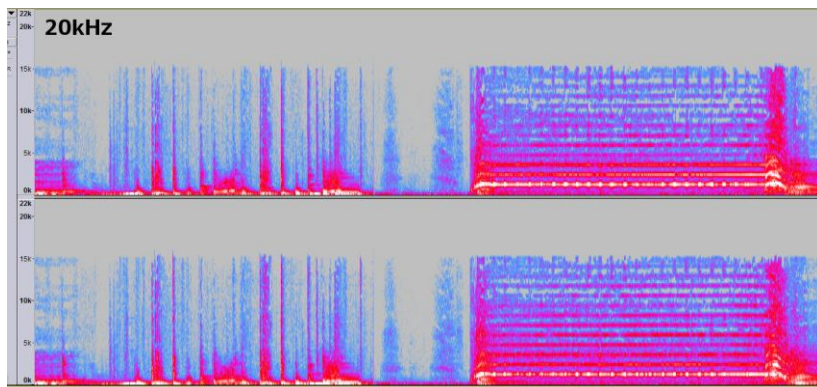
- There are two spectrograms in each screenshot. Why?
- The spectrograms are brutally capped at 15 kHz. Why?
- So... how do you think I made them?

1. Oh Mother You (in a shed) 15 – 28 s
2. Call This Time Love near the end
3. Memento (Vivaldi aria) near the start

- Can you match spectrograms X, Y and Z to the clips?



Laura Moody Super Quiz! 2

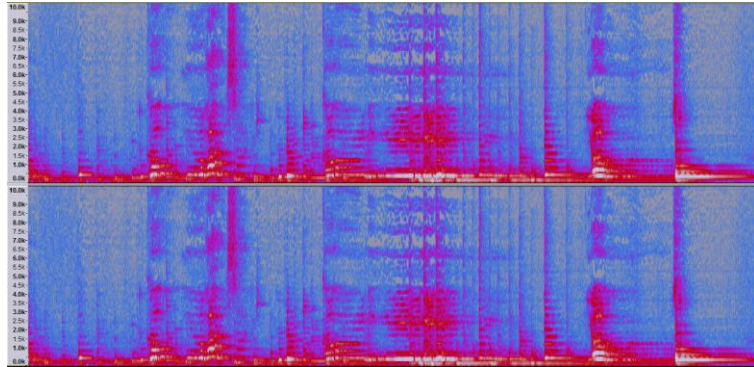


Why the wide
frequency range?

Singing style?
Playing technique?



Laura Moody Super Quiz! 3

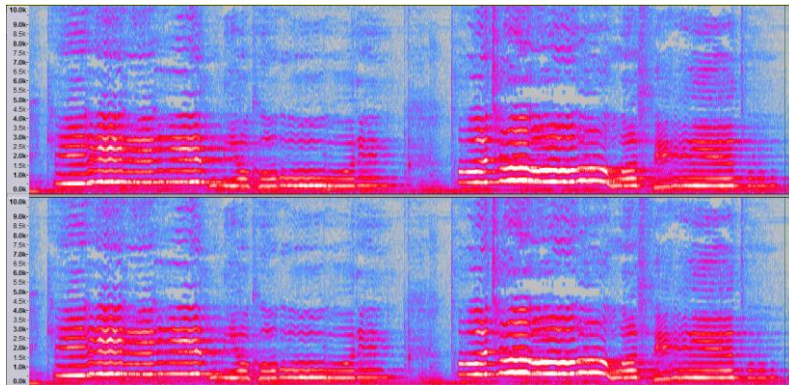


Does pizzicato produce
“purer” tones than bowing?

Singing formant?



Laura Moody Super Quiz! 4



Vocal folds = “LFO”?

Nice glissando?



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Example exam question

"No page in history, baby, that I don't need – I just want to make some eardrums bleed"
(Heavy Duty Rock 'n' Roll, Spinal Tap).

- (a) Jimi Hendrix often played electric guitar using two amplifiers, each with power 100 W and driving four speaker cabinets, each cabinet in turn containing four 300 mm diameter speakers. If the sound pressure level (SPL) at the front of the audience 6 m away from the speakers is 115 dB, *estimate* the SPL around the player, 2 m away from the speakers. Explain your reasoning, including unknown factors which may have an influence. **{6}**
 - (b) Estimate the efficiency of the speaker/amplifier combination in turning electrical energy into sound energy. **{2}**
 - (c) If the Noel Redding, the bass player of The Jimi Hendrix Experience, had a similar backline rig (same amplifier power and speakers) discuss whether his playing would sound *subjectively* as loud as Jimi's? **{2}**
 - (d) Discuss developments in Western classical instrumentation and/or voice technique, particularly in the 17th and 18th centuries which were, in your view, at least partly driven by a desire for greater loudness. **{5}**
- 1 hour, answer 3 questions from a choice of 6.
 - "Closed book", but a data sheet will be provided with key formulae, tables and diagrams.



Supplementary...

1. Who invented the "metal umlaut"?

- A. Motörhead
- B. Blue Öyster Cult
- C. Queensrÿche
- D. Someone else



2. This liner note is from which 1971 album?

TECHNICIÄNS ÖF SPÅCE SHIP EÄRTH
THIS IS YÖÜR CÄPTÄIN SPEÄKING
YÖÜR ØÄPTÄIN IS DEÄD

"The synthesizers warble, woof and scream and gurgle like barfing computers"



Supplementary



'... "adventurous" and "good" aren't always one and the same.'



Example exam answer

(a)

① Point source: energy drops as SQUARE of distance
Speaker backline is quite big, so probably
drops off less rapidly in this case.
Assume $1/\text{distance}$ (this is a guess).

① Energy or $\frac{4+2}{2} = 3\times$ higher at Jini *Any sensible staircase*

① Not taking into account absorption or reflection.

① Audience may be below line of speakers.

$p^2 \propto I$ so pressure drops by $\sqrt{3} \approx 1.7 \approx 2$ } *sensible calculation*
Jini sees $115 + 10 \log_{10}(2) = 118 \text{ dB}$
Pain threshold $\approx 120 \text{ dB}$!



Example exam answer

(b) Right by speaker (area $\approx 1 \text{ m}^2$) $\approx 120 \text{ dB}$ ①
So they are radiating $\sim 1 \text{ W}$. ①
Efficiency $\approx \frac{1 \text{ W}}{100 \text{ W}} = 1\%$ ①

(c) Probably less loud. Bass frequencies below
peak of ear sensitivity: $2 \text{ kHz} - 4 \text{ kHz}$. ①
Subjective loudness affected by attention:
Jini is "ham man"! } ①
Distortion on guitar (wailing/screaming) \Rightarrow
subjectively louder through tymbre.



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2D oscillators

- **Key concepts**
 - Discrete **modes**
 - Modes associated with resonant frequencies
- **Example – circular oscillating plate**
 - Can be solved analytically
 - Solutions involves Bessel functions
 - **MATLAB analysis**
- **Real instruments**
 - Much more complicated!
 - Even solid-bodied instruments have important body resonances (contrary to what MT says)



Violin

The acoustics of the violin: a review

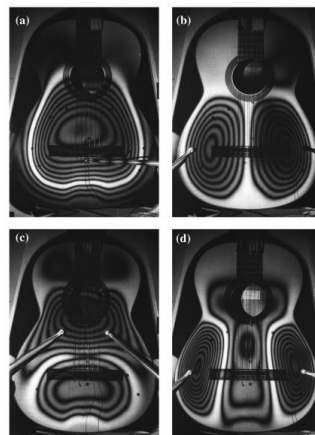
Jim Woodhouse
Reports on Progress in Physics,
Volume 77, Number 11

See post on forum (thanks Rudo!)

“theoretical modelling
needs to adopt a
methodology that
recognizes the futility of
trying to predict every detail
of response”

c.f. what I said about physical
modelling synthesis last week

Rep. Prog. Phys. 77 (2014) 115901



Yes, I know, it's a guitar...



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Peer Assessment

I think it is a great idea for marks to be agreed in a group before they are awarded, this will allow a discussion to take place, which I think will be helpful. It is sometimes hard to distinguish between two neighbouring marks on the 17 point scale (particularly the high 2.1 and the low first)

more emphasis should be placed on how accessible the content of each presentation is to all the different disciplines included in the module.

Maybe it'd be an idea to split the marking groups so that there's perhaps one physicist, one mathematician, one philosopher, etc as far as is possible.

- Quality of presentation material
 - Slides, demonstration material, sounds, music
 - Presentation clearly describes project goals and outputs
- Quality of presentation
 - Address whole audience, good timing, good speaking / non verbal skills
- Interdisciplinary content
 - Understandable by any UG, content beyond single discipline



Term 2 dates

Week 1 exam

Week 2 project presentations and peer assessment

Week 3 SofM Jam Session!