



UNIVERSITY of
ROCHESTER

PHY 103

Percussion:

Drums

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Reading

▶ Reading for this week:

- Hopkin, Chapter 7
- Fletcher and Rossing, Chapter 3 (for advanced background material)

Percussion Instruments

- ▶ Percussion instruments are divided into two types:
 - **Membranophones**
 - Drums
 - **Idiophones**
 - Chimes, xylophones, marimbas, jaw harps, boos, tongue drums, bells, gongs
- ▶ Could also be divided into instruments with pitch and instruments without pitch
- ▶ Q: do drums have pitch?

Types of Membranophones

- ▶ **Struck**: vibrations produced by sticks, hands, etc.
 - Timpani/kettledrum, snare, taiko, tabla, bongo, ...
- ▶ **String**: vibrating string attached to drumhead
 - Found in South Asia (Indian drum)
- ▶ **Friction**: rubbing motion causes drumhead to vibrate
 - Irish bodhrán, Brazilian cuica, etc.
- ▶ **Singing**: vibrating membrane modifies another sound
 - Kazoo

Drum Components

1. Drumhead

- Animal skin, fabric, plastic, fiberglass
- Light and thin: more overtones, “bright” sounding
- Heavy and soft: lower tones, “darker” sound

2. Body

- Frame for drumhead and resonant cavity

3. Attachment of head to body

- Staples, screws, tape, rubber bands, etc.

Effect of the Drum Body

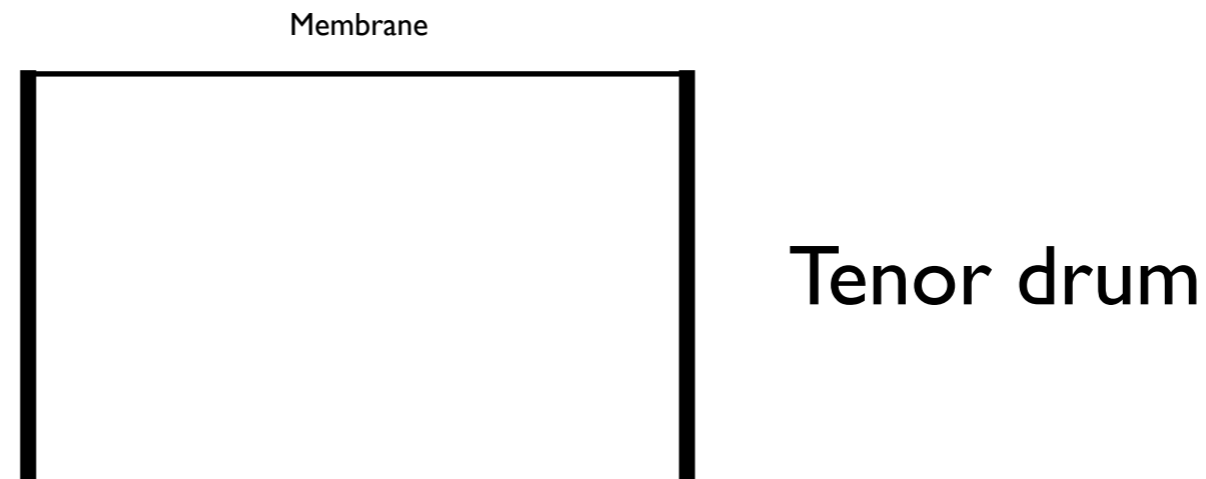
- ▶ The drum body (if there is one) provides a resonant cavity for the vibrating membrane
- ▶ What does this drum sound like?



- ▶ No enclosure, **no air resonance**
- ▶ Front and back of drumhead are **out of phase**, causing cancellation of low-frequency overtones
- ▶ Sound is loud but **lacks depth** due to cancellations

Effect of the Drum Body

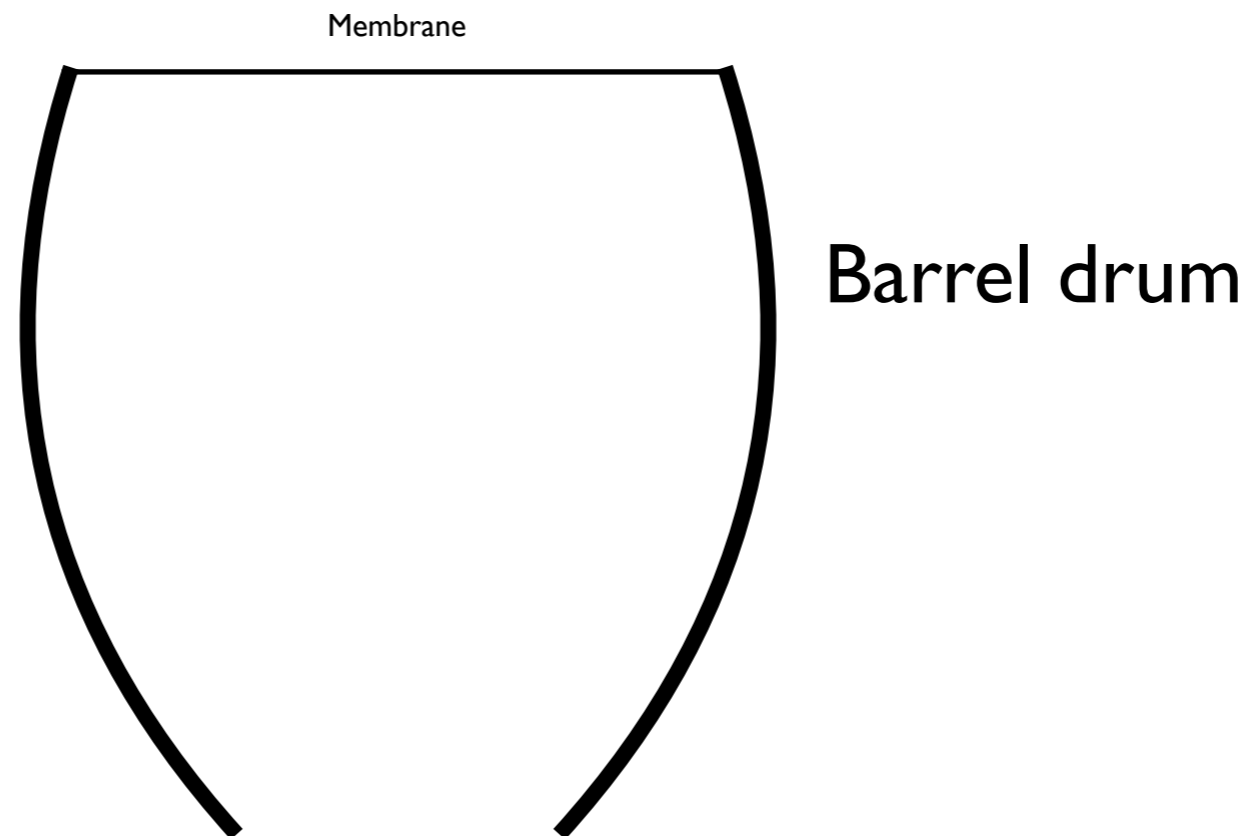
- ▶ What does this drum sound like?



- ▶ Bigger enclosure than frame drum, **more resonance**
- ▶ Less cancellation from front/back of drumhead
- ▶ Fuller, **deeper sound**

Effect of the Drum Body

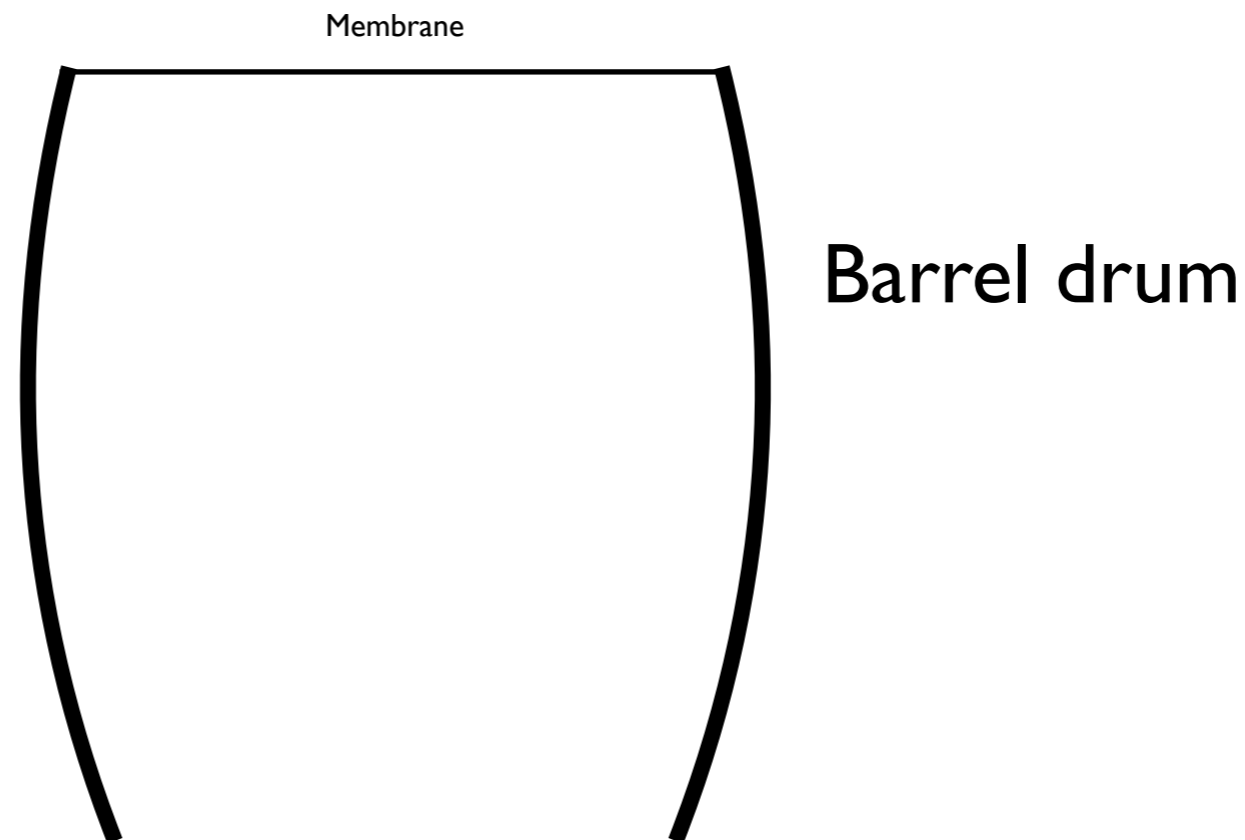
- ▶ What does this drum sound like?



- ▶ Strong air resonance in barrel, **very full sound**
- ▶ Drumhead tone can differ from resonance tone and both can be heard separately

Effect of the Drum Body

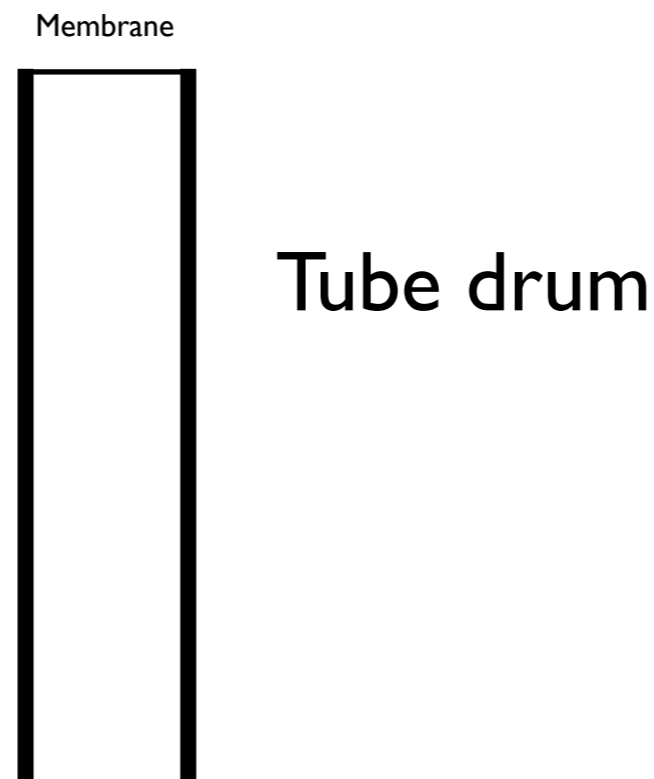
- ▶ What does this drum sound like?



- ▶ Air resonance has **broad frequency peak** and **higher range** than the narrower barrel drum

Effect of the Drum Body

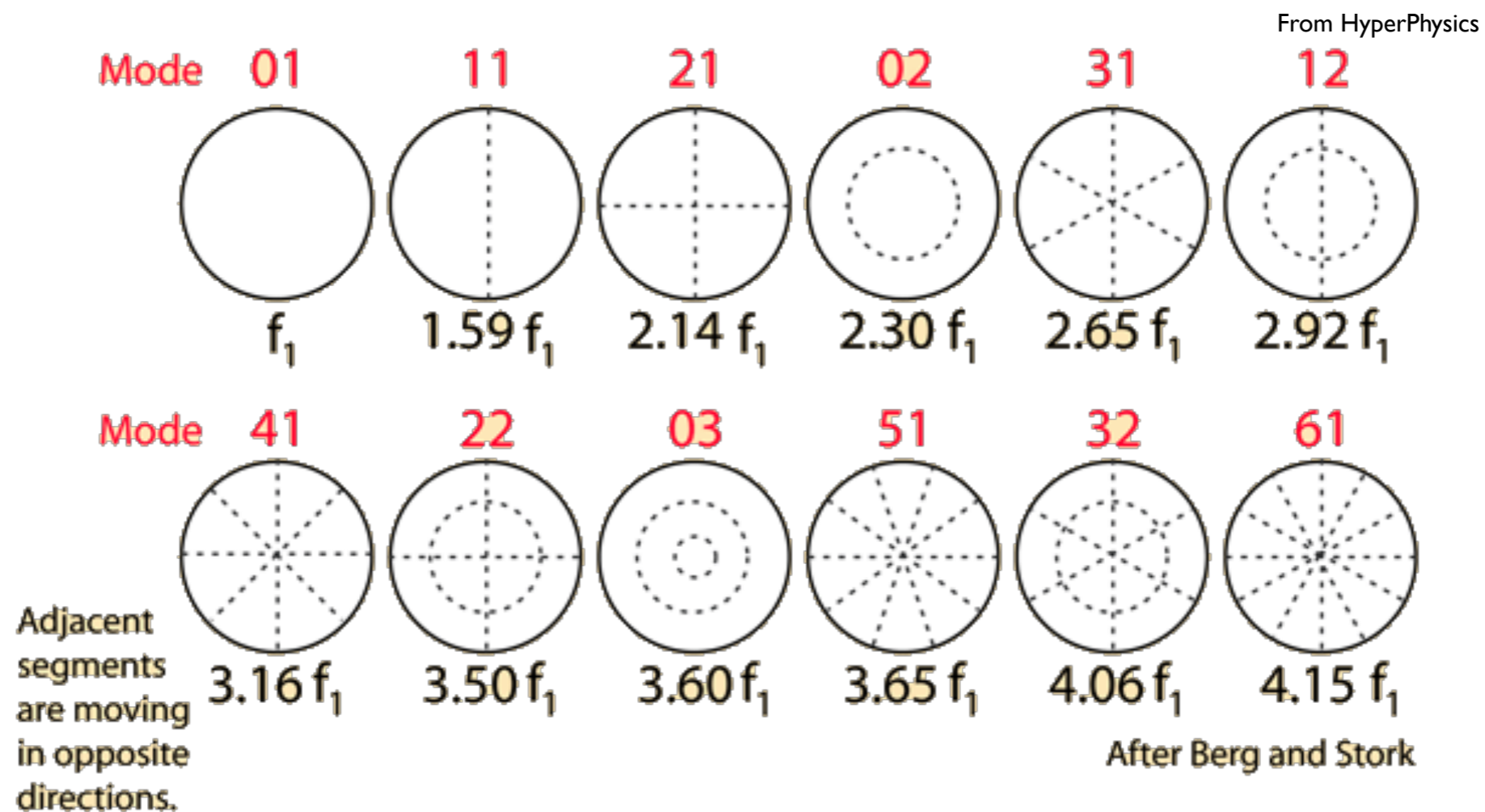
- ▶ What does this drum sound like?



- ▶ Tube has **strong, narrow air resonance peak**
- ▶ Drumhead resonance is likely **far above** the tube resonance (note: $f \sim 1/D$)

Modes of Circular Membrane

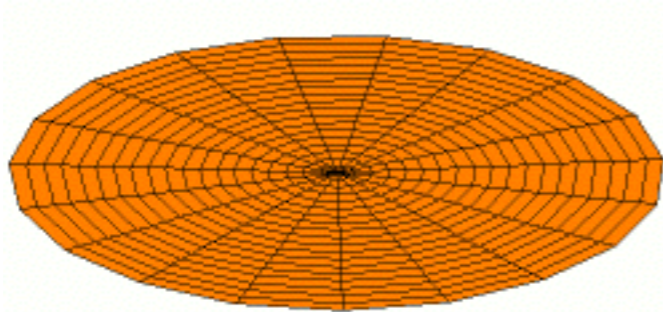
- ▶ A circular drumhead several kinds of vibrational modes:
 - **Radial**: changes as a function of distance from center
 - **Azimuthal**: changes as function of angle



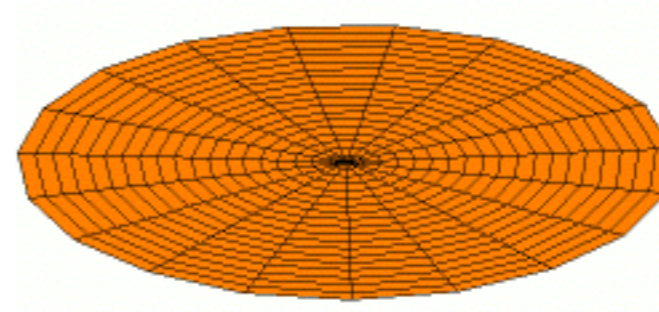
Lowest Four Modes

- ▶ Note that the modes are **inharmonic**

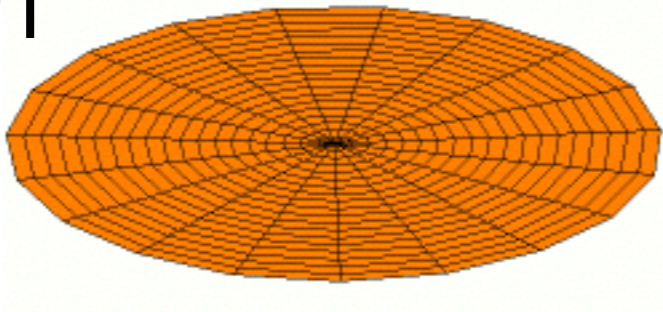
01: f_1



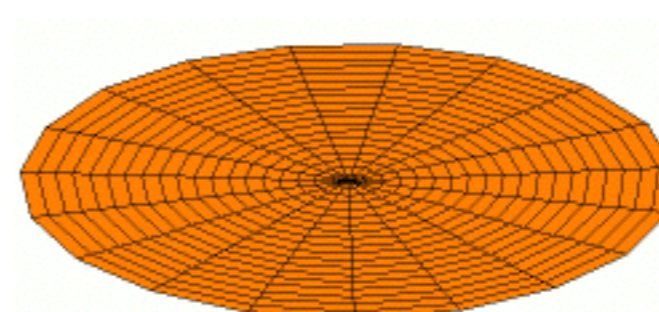
11: $1.59 \times f_1$



21: $2.14 \times f_1$



02: $2.30 \times f_1$



- ▶ We can observe these in a real membrane using a speaker and a strobe light

Predicted Frequencies

- ▶ The frequencies of the membrane's vibrational modes depend on the size, density, and tension of the membrane
 - Need to account for material properties
 - Need to account for shape

- ▶ **Fundamental frequency** of a circular membrane:

$$f_1 \approx 0.766 \frac{\sqrt{T / \sigma}}{D}$$

T = tension

σ = surface density

D = diameter

- ▶ Like a string, the frequency **increases** with tension

Struck Drum: Snare

- ▶ Adjustable tension using screws on the rim of the drum



“Chavala” (Buddy Rich)

- ▶ Played with drumsticks (or brushes and hands). Used historically in military drum corps; a key component of percussion in orchestral music, jazz, and rock music

Struck Drum: Tabla

- ▶ Main drum: wooden body, distinct **high pitched sound**

Zakir Hussain



- ▶ Larger drum: steel body, dark sound. The drummer adjusts the tension in the membrane with the heel of his hand

African Talking Drum

- ▶ The talking drum has two drumheads connected by **tension chords**



Ayan Bisi Adeleke (Nigeria)

- ▶ The drummer squeezes the chords using his arm and body (or legs) to change the tension and pitch of the drum
- ▶ The pitch of the drum is varied to mimic the tones of speech

Q: What is the Cymbal?

- ▶ Idiophone or membranophone? Explain your answer!



The Drum Set

- ▶ In case you were starting to worry that percussion is for men only...



Mi-Gu (Yuko Araki), Yo Gabba Gabba! (c) 2007

Friction Drum: Bhodrán

- ▶ Traditional Celtic drum... or a mid-20th Century invention

Bhodrán (Rónán Ó Snodaigh)



Bhodrán (Patrick T. Reilly)



- ▶ Played by brushing the hand against the drumhead and damping from behind with the non-dominant hand. Can also be played with a **tipper**

Cuica (Brazil)

- ▶ Friction drum with a stick attached to the inside of the drumhead. A key component of **samba**



Fabiano Salek, Bernado Aguiar, Luiz Augusto, Thiaguinho Castro

- ▶ Rubbing the stick produces a vibration, whose pitch is changed by adjusting **tension in the drumhead**
- ▶ You can make a cuica easily out of an empty coffee can

Make Your Own Cuica

- ▶ **Coffee-can cuica**, from Hopkin Ch. 7, p. 104:
 - Empty coffee can with plastic lid, 1/8" bamboo skewer, scrap of chamois or cotton rag, duct tape
 - Drill 1/16" hole in center of plastic lid
 - Push through skewer so that 1/2" protrudes and affix it with 1/2" strip of duct tape wrapped around the stick and snug against the lid
- ▶ Wet the scrap of rag, hold the can with one hand, pinch the stick with the rag and **rub back and forth**
- ▶ Greater pressure increases the tension in the lid, resulting in higher frequency

Summary

- ▶ **Membranophones** are percussion instruments based on the excitation of a drumhead under tension by striking, friction, or sympathetic vibration
- ▶ The overtones in membranophones are **inharmonic** due to the complexities of the material and shape of the instrument, including the air cavity
- ▶ Excitations can include:
 - **Azimuthal modes**, adjacent areas moving up/down
 - **Radial modes**, circularly symmetric excitations