KREP

2025

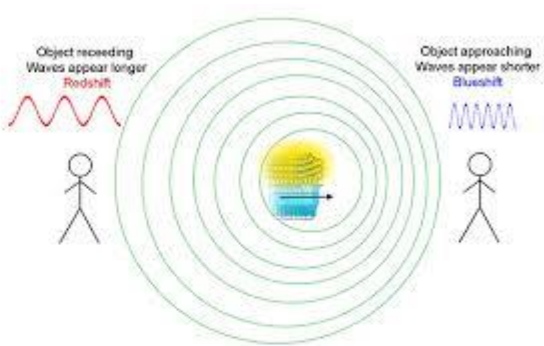
# KARNATAKA RADIOLOGY EDUCATION PROGRAM

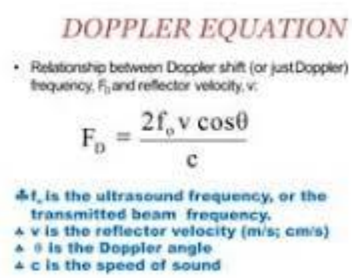
## DOPPLER ULTRASOUND

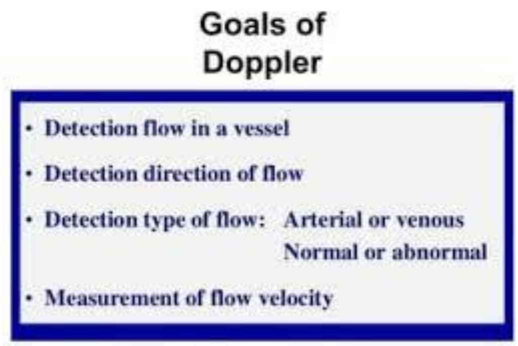
Christian Andreas Doppler( 29 November 1803 – 17 March 1853) was an Austrian mathematician and physicist. He formulated the principle – now known as the Doppler effect – that the observed frequency of a wave depends on the relative speed of the source and the observer.

**The Doppler effect is the change in the frequency of a wave in relation to an observer who is moving relative to the source of the wave.**

**The Doppler Effect is a well-known phenomenon in which the motion of the source of a sound in relation to a receiver causes an apparent change in the frequency of the sound that can be measured.**






**The different types of Doppler ultrasounds include:**

**Color Doppler: A computer changes the sound waves into different colors to show the direction of blood flow.**

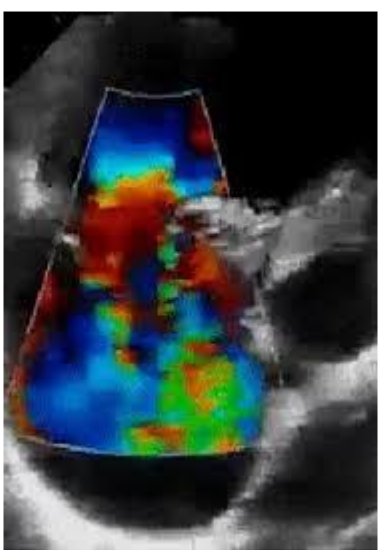
**Spectral Doppler: Graphical representation of blood flow over time.**

**Duplex ultrasound: Combines traditional ultrasound pictures with Doppler ultrasound. It can check the width of blood vessels and can help show blockages.**

**Power Doppler: This test is used to shows the presence of blood flow and can be used to show very slow blood flow. It doesn't show the direction of blood flow. Providers may use power Doppler to study blood flow inside organs.**

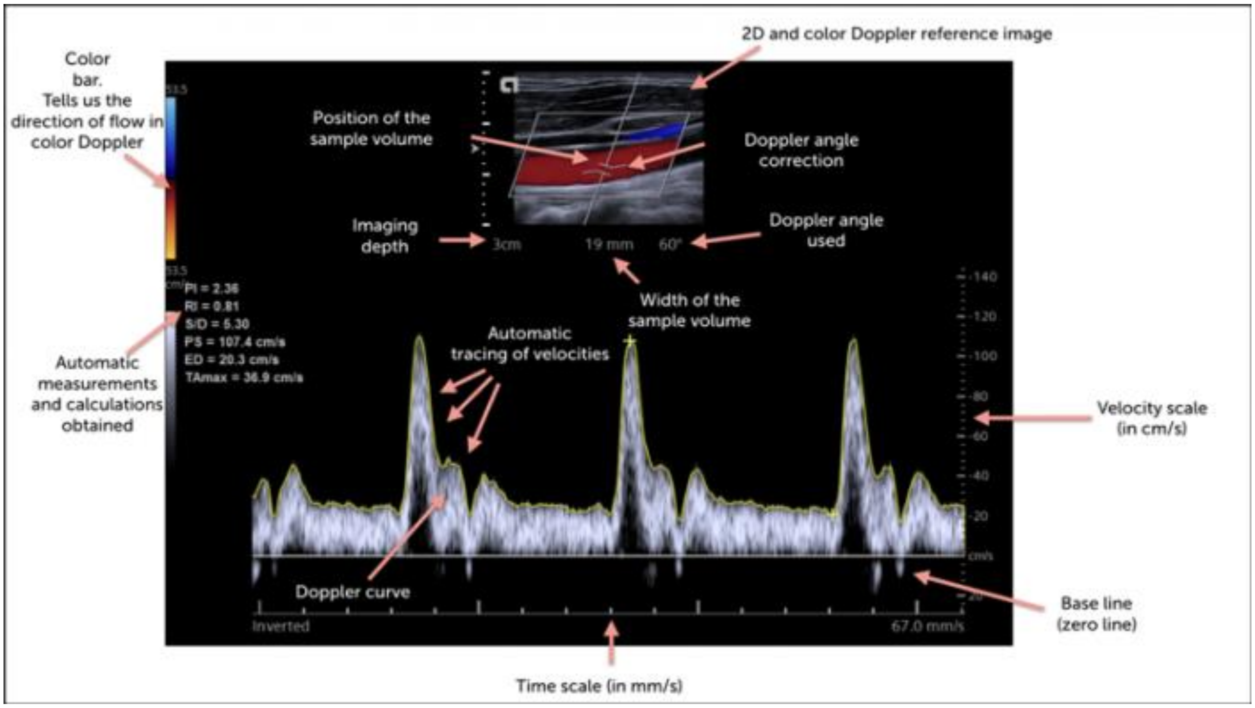
**COLOR DOPPLER**

**The use of color flow Doppler (CFD) or color Doppler imaging (CDI) (or simply color Doppler) sonography allows the visualization of flow direction and velocity within a user defined area. A region of interest is defined by the sonographer, and the Doppler shifts of returning ultrasound waves within are color-coded based on average velocity and direction**



**SPECTRAL DOPPLER**

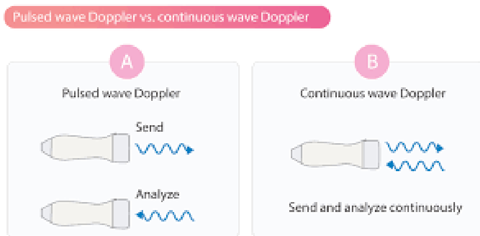
**Spectral Doppler refers to ultrasound modalities which yield graphical representations of flow velocity over time.**

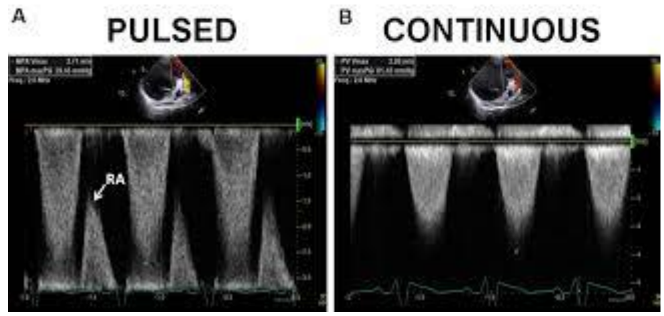



**These velocity-time spectral recordings may be obtained with two conventional modalities, both of which are typically used in conjunction with B-mode ultrasonography; pulsed wave and continuous wave Doppler.**

**Continuous wave Doppler : simultaneously transmits and receives sound waves with separate piezoelectric crystals, recording every velocity received along a path defined by the operator. It is capable of recording the direction and velocity of flow even at high velocities but is unable to localize from where individual velocity elements originate.**

**Pulsed wave Doppler : In pulsed wave Doppler, the user defines a small area (the sample "volume" or "gate") within the B-mode image, and (based on pulse repetition frequency, or the time required for returning sound waves) only the Doppler shifts from that area are recorded. While avoiding the range ambiguity of continuous wave Doppler, the intermittent sampling of pulsed wave Doppler, especially at targets that are further away from the transducer, renders the modality vulnerable to aliasing at higher velocities**

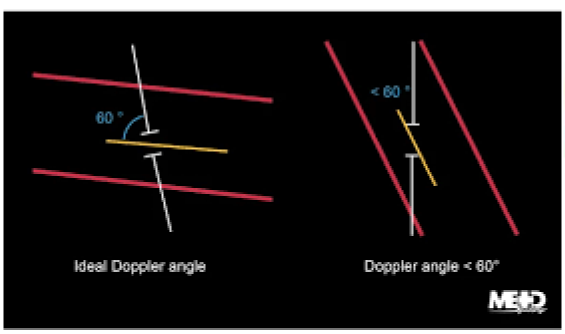


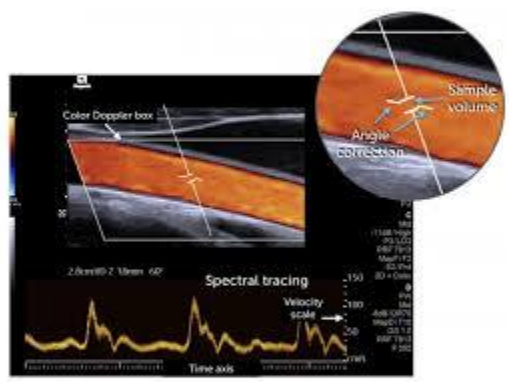




**DOPPLER ANGLE**

**Measurement of flow velocity with Doppler imaging is dependent on the angle between the ultrasound beam and the target (insonation angle), with the maximum and true velocity achieved at 0 degrees (parallel to the target). In most clinical scenarios, an insonation angle of 0 degrees is impractical and angle correction can still be applied to achieve an accurate velocity measurement .**

**Angle correction is considered accurate for diagnostic purposes at insonation angles less than 60 degrees**




**The Nyquist limit always equals Pulse Repetition Frequency (PRF)/. The US machine can display the Nyquist limit either as the maximum measurable blood flow velocity or in kHz at the top and bottom of a velocity range on a color scale. If the unit is in kHz, it represents the maximum measurable Doppler shift .**

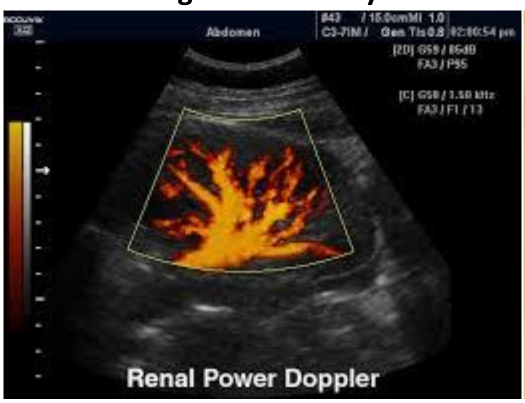
**If the blood flow velocity exceeds this limit the device will incorrectly register the direction and velocity of the flow, resulting in color or spectral Doppler aliasing artifacts . The maximum measurable velocity of pulsed Doppler is 1 m/s at 6 cm depth**

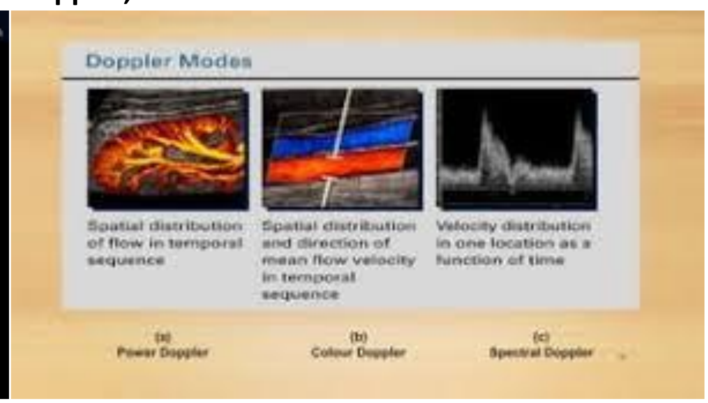
**Aliasing is a phenomenon inherent to Doppler modalities which utilize intermittent sampling in which an insufficient sampling rate results in an inability to record direction and velocity accurately**

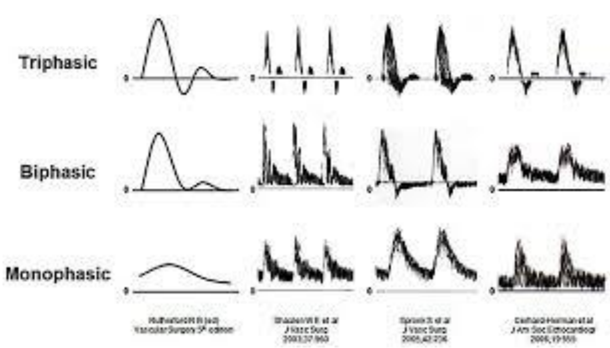
**Power Doppler**

**is a technique that uses the amplitude of Doppler signal to detect moving matter.**

- **is independent of velocity and direction of flow, so there is no possibility of signal aliasing**
- **is independent of angle, allowing detection of smaller velocities than color Doppler, facilitating examinations in certain technically challenging clinical setting**
- **has higher sensitivity than color Doppler, which makes a trade-off with flash artifacts**




**DIFFERENT WAVE FORMS ARE SEEN IN DIFFERENT VESSELS, which are explained in respective systems.**

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**REF : Christensen’s Physics of Diagnostic Radiology,Radiopedia.**
**Christensen’s physics of diagnostic radiology**