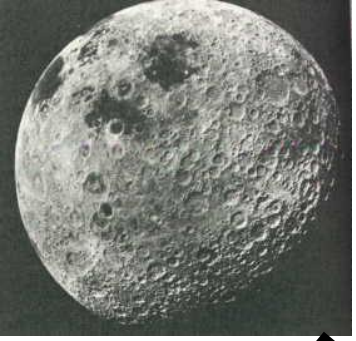
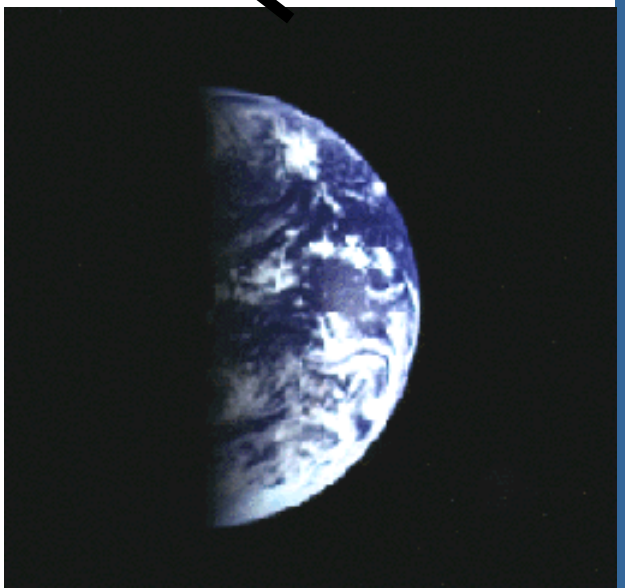


UNDERSTANDING DOPPLER SHIFT

(Critical Knowledge for Successful EME)

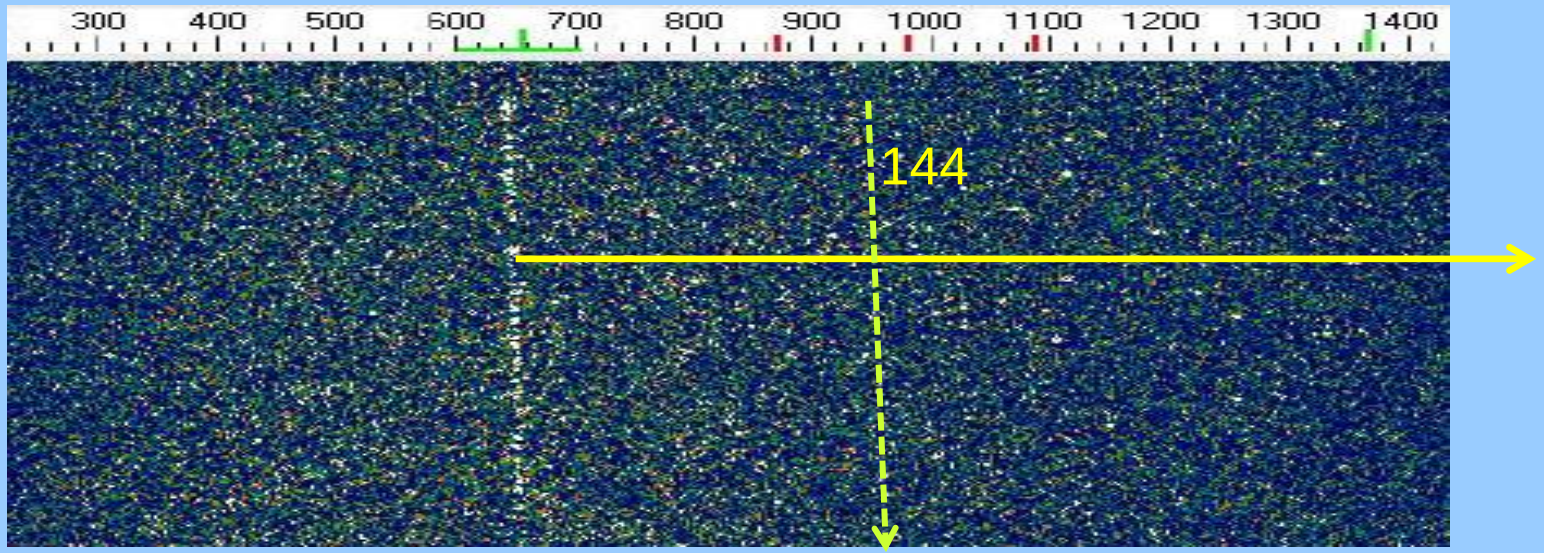
BY AL, K2UYH
alkatz@tcnj.edu



- INTRODUCTION
- BASICS
- WHERE TO TX & RX
- LISTENING ON YOUR ECHO VS. TX FREQ
- WHERE TO CALL & LISTEN
- FINDING DX
- CONCLUSIONS

UNDERSTANDING DOPPLER CRITICAL TO SUCCESSFUL EME ON THE HIGHER EME BANDS

IMPORTANT CW OR JT



- ON 144 MAX ΔF ~ 350 Hz
- ON 1296 MAX ΔF > 3 kHz
- ON 10 GHz MAX ΔF > 30 kHz

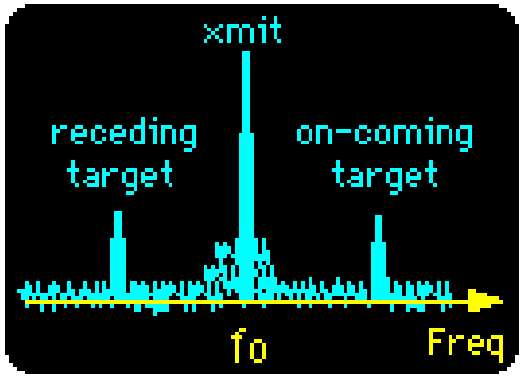
MAX ΔF ~ 2.5 F(in MHZ) in Hz

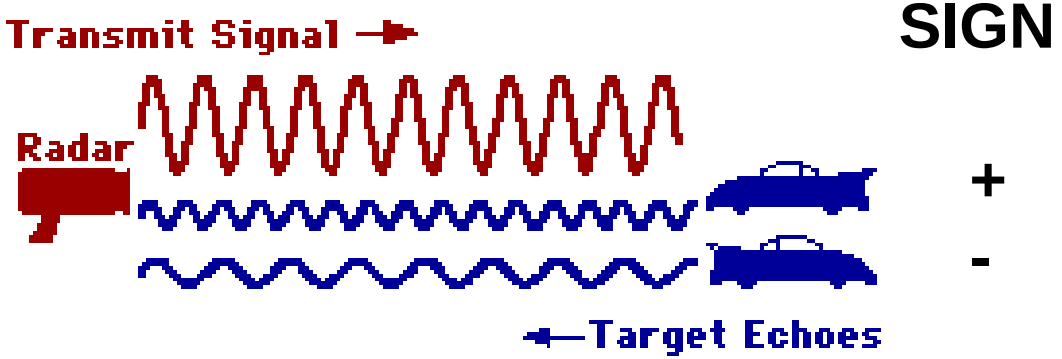
DOPPLER BASICS

THE FREQ SHIFT DEPENDS ON THE RELATIVE VEL, V

fr = ft C / (C + V)

C IS $3x10^8$ m/s (SPEED OF LIGHT),





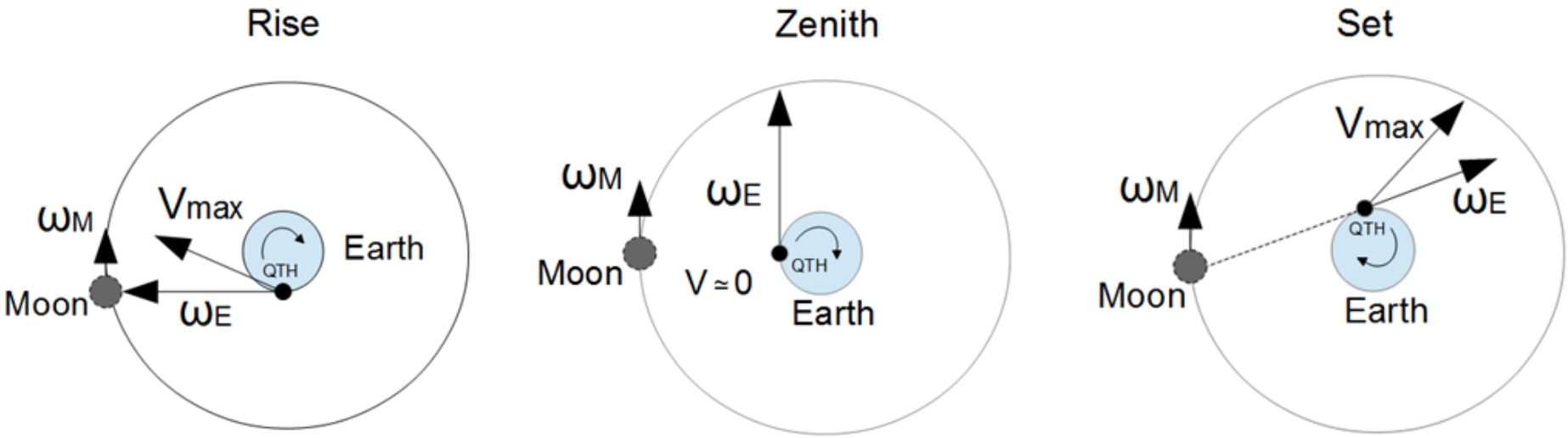
MOONBOUNCE MORE COMPLICATED:
TWO PATHS, TO AND FROM THE MOON

$fr= ft\ C^2 / [(C + Vt) (C + Vr)]$

DOPPLER BASICS

WHEN LISTENING TO YOUR OWN ECHOES, Vr AND Vt ARE THE SAME

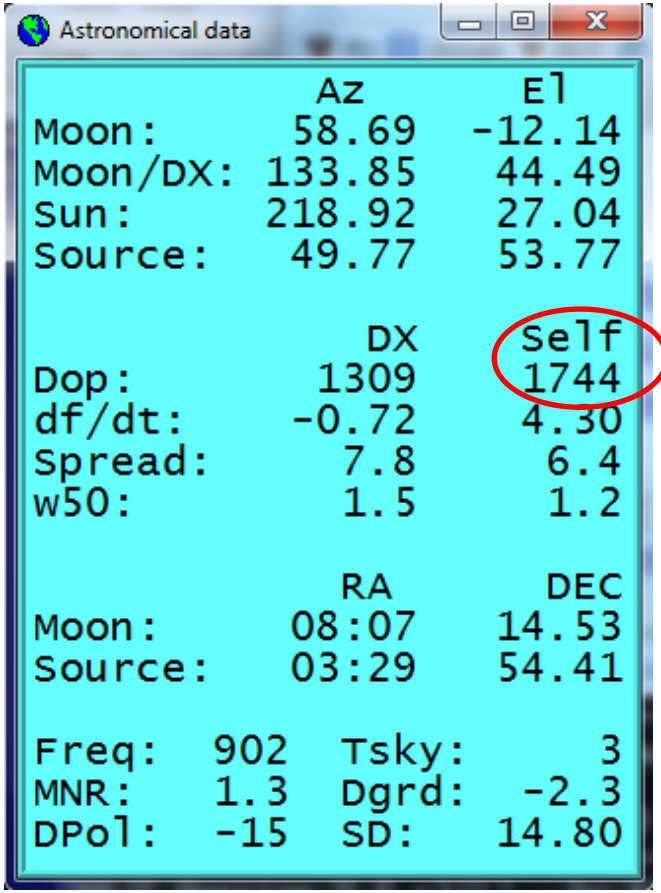
$$fr = ft\ C^2 / (C + V)^2$$



AT RISE V AND Δfr +MAX
AT ZENITH V AND Δfr ~0
AT SET V AND Δfr -MAX

DOPPLER BASICS

THIS FREQUENCY SHIFT, **Δfr** IS YOUR SELF DOPPLER SHIFT (**SDS**) AND GIVEN IN THE WSJT ASTRONOMICAL DATA BOX



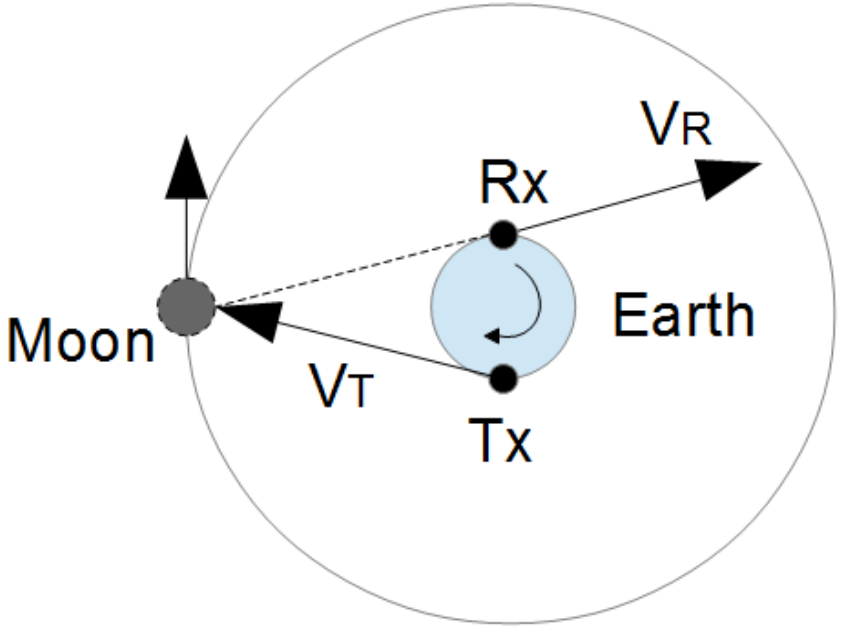
SDS

DOPPLER BASICS

THINGS GET COMPLICATED WHEN LISTENING TO A STATION LOCATED AT A DIFFERENT PLACE ON THE EARTH.

Vt AND **Vr** ARE NOT THE SAME.

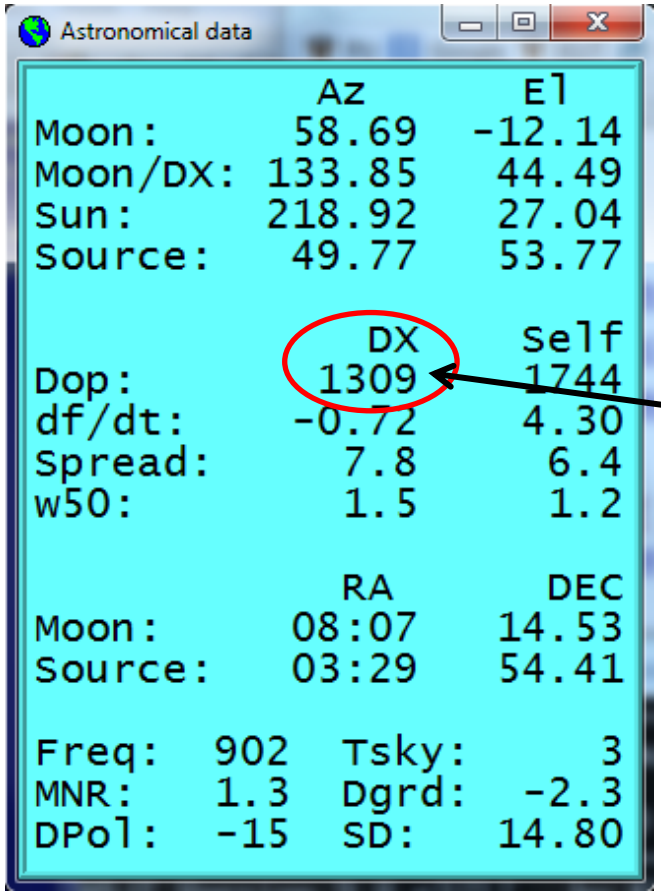
THE MOON MAY BE MOVING **TOWARD TX** AND **AWAY FROM RX**

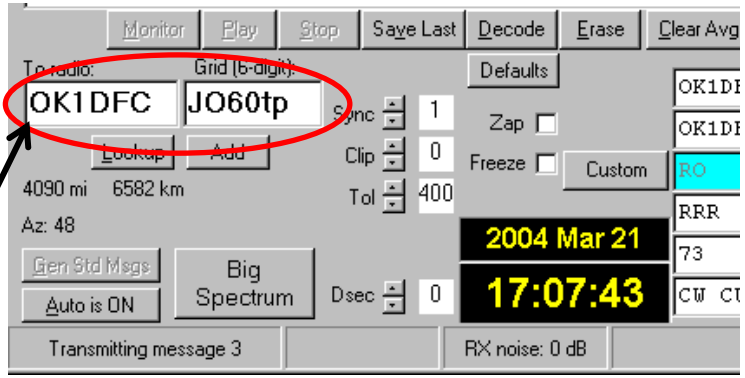


DOPPLER BASICS

THE FREQUENCY DIFFERENCE BETWEEN TX (FT) AND RX (FR) CAN BE **VERY DIFFERENT** THAN THE SDS.

THIS SHIFT IS THE MUTUAL DOPPLER SHIFT (**MDS**).





MDS

EXAMPLE:

IF DX IS TXing AT 033,

YOU WOULD COPY HIM AT 033 + 1.31 = 034.311

YOUR ECHOES WOULD BE AT 033 + 1.74 = 034.74

LISTENING ON YOUR ECHO

A KEY INSIGHT FROM THE EQUATIONS:

IF YOU SET YOUR TX FREQ (ft) SO THAT YOUR ECHOES (SDS) FALL ON THE SAME FREQUENCY AS YOU HEAR A STATION (fr), THAT STATION WILL HEAR YOU ON THE SAME FREQUENCY AS HIS OWN (SDS) ECHOES.

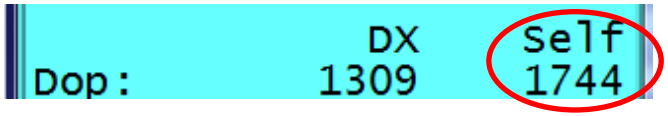
FOR RANDOM OPERATION: **ALWAYS LISTEN ON YOUR ECHO FREQUENCY**.

WHEN REPLYING TO A CQ, SET YOUR TX FREQ (ft) SO THAT YOUR EHCOES FALL ON THE RX FREQ (fr).

TO ACCOMPLISH THIS SET YOUR RIT TO YOUR SDS

ALTERNATE SPLIT OPER.

RIT

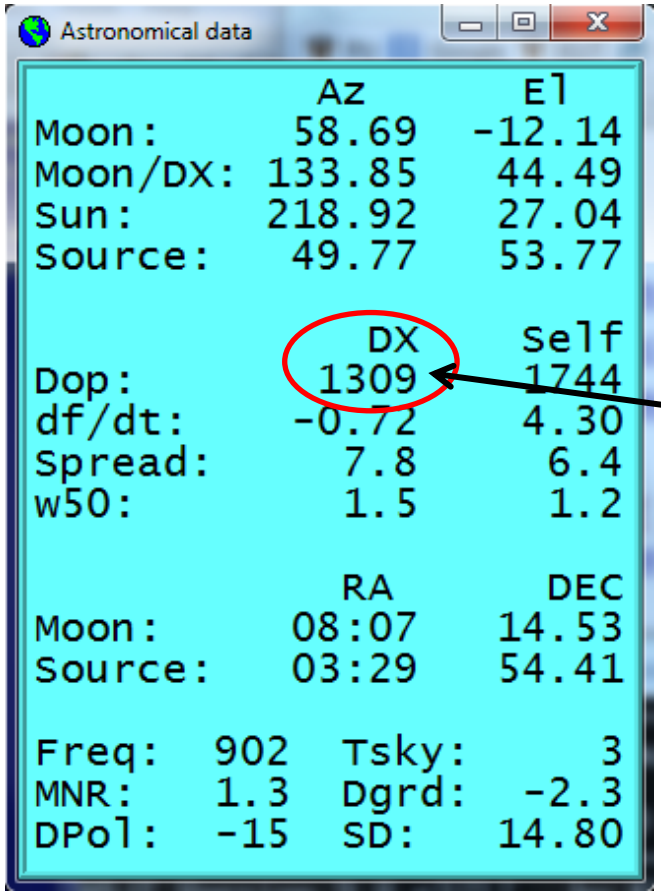


SDS

SKED OPERATION

<u>FOR SKED OPERATION</u>, BOTH STATIONS OFTEN TX ON THE SKED FREQ.

YOU THEN LISTEN ON THE MDS



MDS

EXAMPLE:

IF SKED IS ON <u>070</u>,

YOU WOULD LISTEN AT <u>071.3</u> [SET RIT TO 1309]

THE DX WOULD LISTEN THE SAME PLACE

YOUR ECHOES WOULD BE AT <u>071.74</u>

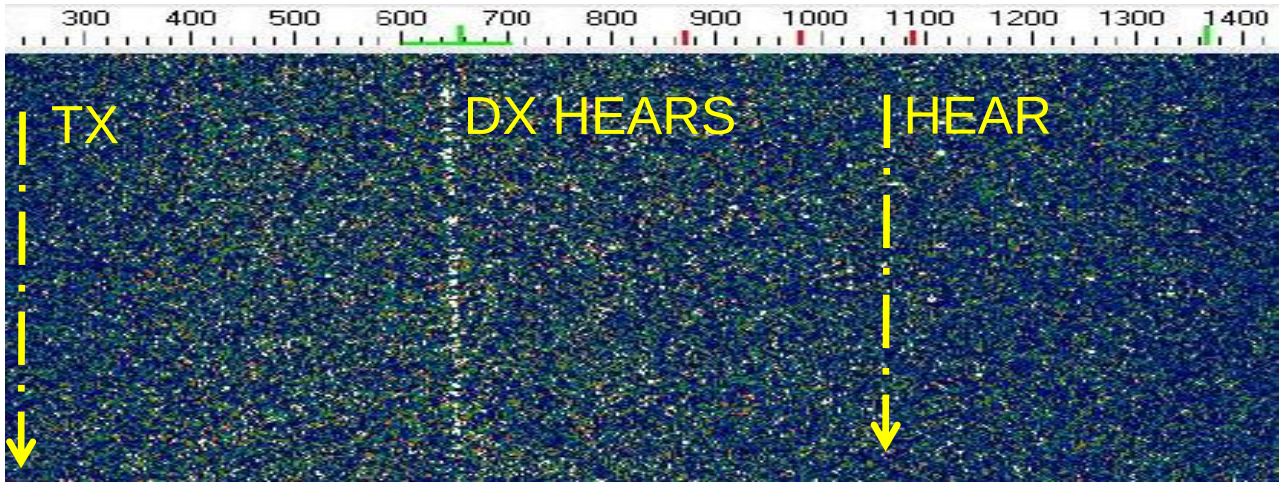
LISTENING ON TX FREQ

DX OFTEN WANT REPLIES ON THEIR TX FREQ.

YOU LISTEN ON THE MDS, BUT YOU TX on

ft = fr **– 2 MDS**

WHERE **fr** IS THE ACTUAL FREQ THE DX IS COPIED ON



090 DX (TX/RX)⟶ RX +460 Hz

TX -920 Hz ⟵

EXAMPLE:

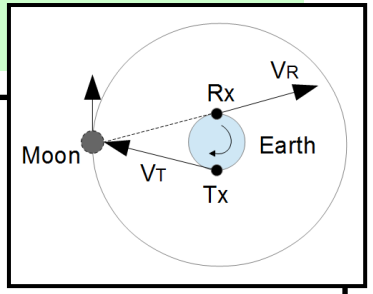
IF DX FREQ IS 090, AND MDS IS 460 Hz

YOU WOULD LISTEN AT 090.46 WITH YOUR RIT SET TO 2 X 460 = 920 Hz

CALLING ON A SPECIFIED FREQ

FOR DX OPERATION THE WORST SITUATION IS WHEN EVERYONE IS CALLING ON A SPECIFIED FREQ.

THE FREQ YOU ARE HEARD ON DEPENDS ON YOUR LOCATION (AND ON THE MOON'S POSITION).



FOR EXAMPLE ON 23 CM WITH A DX FREQ OF 090:

THE DX WILL HEAR –

NEAR MOONRISE, NEARBY STATIONS ~ 3 kHz ABOVE 090, BUT STATIONS FAR TO EAST ~ 0.5 kHz HIGHER.

NEAR ZENITH, NEARBY STATIONS WILL ALL BE AROUND 090, BUT STATIONS FAR TO EAST ~ 1.5 kHz HIGHER, AND STATIONS FAR TO WEST ~ 1.5 kHz LOWER.

NEAR MOONSET, NEARBY STATIONS ~ 3 kHz BELOW 090, BUT STATIONS FAR TO WEST ~ 0.5 kHz LOWER.

TO BE HEARD CLOSE TO NEARBY STATIONS ft = fr – 2 MDS + SDS^{DX}

HOW TO BE HEARD

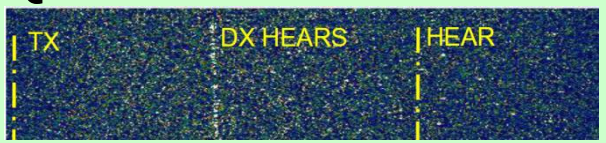
THE GENERAL RULE FOR PUTTING YOUR SIGNAL WHERE IT WILL BE HEARD BY A DX STATION COMMUNICATING WITH ANOTHER STATION (CS) IS

$$\mathbf{ft = fdx - MDS_{dx} + \textit{MDSdx-c}}$$

ASSUMES THE DX AND THE CS ARE TXing ON THE SAME FREQ.

fdx IS DX TX FREQ, OR IF **frdx**, FREQ DX IS HEARD ON

$$\mathbf{ft = frdx - 2\ MDS_{dx} + \textit{MDSdx-c}}$$



MDSdx-c IS THE MDS BETWEEN THE DX AND THE CS. [CAN BE ESTIMATED FROM DX AND CS LOCATIONS AND MOON POSITION].

IF CAN COPY CS, CAN ESTIMATE HIS TX FREQ **Δ** FROM DX WITH YOUR MDS TO HIM. JUST ADD THIS **Δ** TO **ft**.

HOW TO FIND A DX STATION

IF YOU CAN'T FIND A DX BUT COPY OTHER CS, WHERE SHOULD YOU LISTEN?

THE ANSWER IS COMPLICATED BY THE NEED TO KNOW THE PROCEDURE BEING USED BY THE CS.

CASE 1: ASSUMES THE DX AND THE CS ARE TXing ON THE SAME FREQ.

$$frdx = frc - MDS_c + MDS_{dx}$$

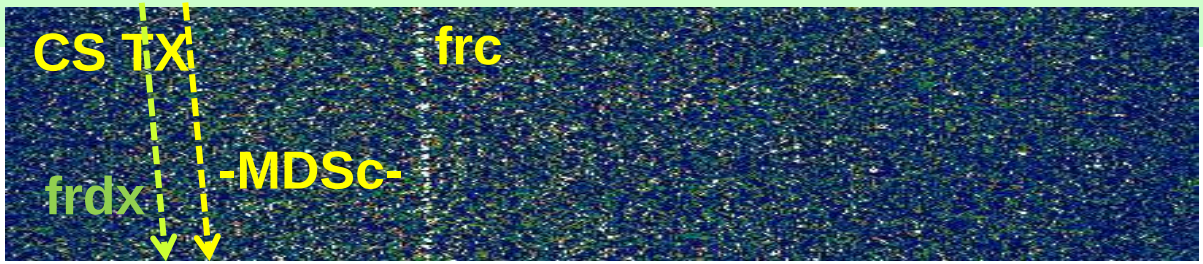
frdx IS THE FREQ TO LOOK FOR THE DX
frc IS THE FREQ THE CS IS COPIED ON
MDSc AND **MDSdx** ARE YOUR MDS RESPECTIVELY TO THE CS AND THE DX.

EXAMPLE:

CS FREQ = 052 kHz
MDSc = 1.2 kHz

MDSdx = - 350 Hz

YOU WOULD LISTEN AT 52-1.2-0.35 = 51.85



HOW TO FIND A DX STATION

CASE 2: ASSUMES THE CS IS TXing SO THAT HIS ECHOES IS ON THE SAME FREQ AS THE DX's ECHOES.

fdx = frc - MDS$_c$ - *MDSdx-c* + SDS$_c$

fdx IS THE DX'S ACTUAL TX FREQ [ASSUMING CS HAS SET HIS FREQ CORRECTLY].

MDS$_c$ IS YOUR MDS TO THE CS

MDSdx-c IS THE MDS BETWEEN THE DX AND CS, AND **SDS$_c$** IS THE CS's SDS. [ESTIMATE FROM DX AND CS LOCATIONS AND MOON LOCATION]

LISTEN AT **frdx = fdx + *MDSdx***

EXAMPLE:

DX C31EME

CS OK1DFC

STN K1JT

MOON NEAR ZENITH IN EU.

frc = 052 kHz

MDSc = 1.2 kHz

***MDSdx-c* ≈ 200 Hz**

SDSc ≈ 80 Hz

C31EME TX FREQ IS 52 - 1.2 - 0.2 + 0.08 ≈ 50.68

K1JT SHOULD LISTEN AT 50.68 + MDSdx ≈ 51.8 kHz

HOW TO FIND A DX STATION

CASE 3: ASSUMES THE CS IS TXing SO THAT HIS ECHOES ARE HEARD BY THE DX ON HIS TX FREQ.

$fdx = frc - MDS_c - MDSdx\text{-}c$

fdx IS THE DX'S ACTUAL TX FREQ.
MDS_c IS YOUR MDS TO THE CS
MDSdx-c IS THE MDS BETWEEN THE DX AND CS.

LISTEN AT **$frdx = fdx + MDS_{dx}$**

MDS_{dx} IS YOUR MDS TO THE DX

EXAMPLE:

DX C31EME

CS OK1DFC

STN K1JT

MOON NEAR ZENITH IN EU.

frc = 052 kHz

MDS_c = 1.2 kHz

***MDSdx-c* ≈ 200 Hz**

C31EME TX FREQ IS 52 - 1.2 - 0.2 ≈ 50.6 kHz

K1JT SHOULD LISTEN AT 50.68 + MDS_{dx} ≈ 51.8 kHz

CONCLUSION

- **THE DOPPLER RULES PRESENTED HERE SHOULD HELP YOU MAKE MORE EME QSOS.**
- THE PREFERRED METHOD FOR RANDOM EME IS TO **LISTEN** FOR CQ REPLIES **ON** THE SAME FREQ AS YOUR **ECHOES (ft + SDS)**. REPLIES SHOULD BE TX SO THAT THEIR ECHOES FALL ON THE FREQ YOU ARE HEARD ON.
- IF YOU COPY A STATION REPLYING TO AN UNHEARD STATION, YOU CAN ESTIMATE WHERE TO LISTEN USING KNOWLEDGE OF DOPPLER (**$frdx = frc - MDS_c + MDS_{dx}$**).
- IF A STATION IS LISTENING ON HIS TX FREQ, YOU SHOULD HEAR HIM ON HIS **TX FREQ + MDS**, BUT SHOULD REPLY ON **– 2 X MDS**.
- IF YOU SKED A STATION, WHERE YOU ARE BOTH TO TX ON THE SAME FREQ, YOU BOTH SHOULD LISTEN ON THE **SKED FREQ + MDS**.