Appendix A. Subroutine WGEOM for the Double Spherical Helix

The subroutine WGEOM is used to generate the geometry of the antenna to be analyzed by the ESP code. The ESP user's manual [22] explains in details how the geometry of a wire antenna should be defined. In this appendix the Fortran source code for WGEOM when the wire antenna is a double spherical helix is presented.

The following parameters in WGEOM subroutine are for the double spherical helix.

NSEGSP	Number of segments per turn on the helix
NSEGSP1	Total number of segments on sphere#1
NSEGSP2	Total number of segments on sphere#2
NSEGSP3	Total number of segments on sphere#3 (if any)
ZOFFSET	Distance the helix is offset from the ground plane in meters
NTOTAL	Number of turns of each sphere if wound fully
AS	Radius of sphere in meters

These data are included at the end of the input file for the READ statements in ESP. Sample input data for a double spherical helix with the lower sphere having 7 turns, and the upper sphere having 4 turns are presented below. The radius of 0.02 meters, and the helix offset above the ground is 0.005 meters.

```
20
140
80
0
0.005
7
0.02
```

The WGEOM subprogram for the double spherical helix is listed below.

```
SUBROUTINE WGEOM(IA,IB,X,Y,Z,NM,NP,NAT,NSA,NPLA,VGA,BDSK,ZLDA,
     +NWG,VG,ZLD,WV,NFS1,NFS2,NRUN,A)
      DIMENSION IA(1),IB(1),X(1),Y(1),Z(1),
     +NSA(1),NPLA(1),BDSK(1)
      COMPLEX VGA(1),ZLDA(1),VG(1),ZLD(1)
      REAL PIE, AS, NTOTAL, NACT
C
C  number of wire segments per turn
      READ(5,*)NSEGSP
C  number of wire segments of each sphere , NSEGSP1, NSEGSP2, NSEGSP3
      READ(5,*)NSEGSP1
      READ(5,*)NSEGSP2
      READ(5,*)NSEGSP3
      NSEG1 = NSEGSP1+1
      NSEG2 = NSEG1+NSEGSP2
      NSEG3 = NSEG2+NSEGSP3
C
C  Length of segment offsetting sphere from ground plane, ZOFFSET
C  If ZOFFSET is not zero there will be one additional segment
      READ(5,*)ZOFFSET
C
      IF (ZOFFSET .GT. 0.0) INDX = 1
      NM = NSEGSP1+NSEGSP2+NSEGSP3 + INDX
C  Total number of wire points, NP
      NP = NM + 1
C  Total number of wire attachment points, NAT
      NAT = 1
C
C  Total number of turns sphere would have if completely wound, NTOTAL
      READ(5,*)NTOTAL
      IF (NSEGSP1 .EQ. NTOTAL*NSEGSP) INDX1 = 90
C
```

```
C  Actual number of turns sphere has, NACT
C     READ(5,*)NACT1
C     READ(5,*)NACT2
C     READC(5,*)NACT3
C
C  Radius of sphere, AS (meters)
      READ(5,*)AS
C  The Spherical Helix geometry is now defined
C
      PIE = 3.1415927
C  SEGPHI is the change in the angle phi (radians) for each segment
      SEGPHI = 2.0*PIE*NTOTAL/REAL(NSEGSP*NTOTAL)
C
C  Define coordinates of wire points and endpoints of segments
      X(1) = 0.0
      Y(1) = 0.0
      Z(1) = 0.0
      IA(1) = 1
      IB(1) = 2
        IF (INDX .EQ. 0) GOTO 101
      X(2) = 0.0
      Y(2) = 0.0
      Z(2) = ZOFFSET
      IA(2) = 2
      IB(2) = 3
  101 DO 100 J = 2+INDX,NP
        IF (J.LE.NSEG1+INDX) THEN
        PHI = SEGPHI*REAL(J-1-INDX)
        TH = ACOS((PHI/(PIE*NTOTAL))-1.00000007)
        X(J) = AS*SIN(TH)*COS(PHI)
        Y(J) = AS*SIN(TH)*SIN(PHI)
        Z(J) = AS*COS(TH) + AS + ZOFFSET
          IF (J.EQ.NP) GOTO 100
        IA(J) = J
        IB(J) = J+1
        ELSE IF (J.LE.NSEG2+INDX) THEN
        PHI1 = SEGPHI*REAL(NSEGSP1)
        TH1 = ACOS((PHI1/(PIE*NTOTAL))-1.00000007)
        Z1 = AS*COS(TH1)+AS
        ZOFFSET1 = (2*AS)+ZOFFSET-(((2*AS)-Z1)*2)
        PHI = SEGPHI*REAL(((NSEGSP*NTOTAL)-NSEGSP1)+(J-(NSEG1+INDX)))
        TH = ACOS((PHI/(PIE*NTOTAL))-1.00000007)
        TPHI =SEGPHI*REAL(J-1-INDX)
        X(J) = AS*SIN(TH)*COS(TPHI+INDX1)
        Y(J) = AS*SIN(TH)*SIN(TPHI+INDX1)
        Z(J) = AS*COS(TH) + AS + ZOFFSET1
          IF (J.EQ.NP) GOTO 100
        IA(J) = J
        IB(J) = J+1
        ELSE
        PHI1 = SEGPHI*REAL(NSEGSP1)
        TH1 = ACOS((PHI1/(PIE*NTOTAL))-1.00000007)
        Z1 = AS*COS(TH1)+AS
        ZOFFSET1 = (2*AS)+ZOFFSET-(((2*AS)-Z1)*2)
        PHI2 = SEGPHI*REAL(((NSEGSP*NTOTAL)-NSEGSP1)+(NSEG2-NSEG1))
        TH2 = ACOS((PHI2/(PIE*NTOTAL))-1.00000007)
```

```
      Z2 = AS*COS(TH2)+AS+ZOFFSET1
      ZOFFSET2 = (2*AS)-(2*((2*AS)-((AS*COS(TH2))+AS)))+ZOFFSET1
      PHI = SEGPHI*REAL((NSEGSP*NTOTAL)-((NSEGSP*NTOTAL)-NSEGSP1)
     &  -(NSEG2-NSEG1)+(J-(NSEG2+INDX)))
      TH = ACOS((PHI/(PIE*NTOTAL))-1.00000007)
      TPHI =SEGPHI*REAL(J-1-INDX)
      X(J) = AS*SIN(TH)*COS(TPHI)
      Y(J) = AS*SIN(TH)*SIN(TPHI)
      Z(J) = AS*COS(TH) + AS + ZOFFSET2
        IF (J.EQ.NP) GOTO 100
      IA(J) = J
      IB(J) = J+1
      END IF
  100 CONTINUE
C
C  Check that smallest segment is greater than twice the wire radius
      SLENGTH = SQRT( (X(NP)-X(NP-1))**2 + (Y(NP)-Y(NP-1))**2 +
     +          (Z(NP)-Z(NP-1))**2 )
      IF (SLENGTH .LE. A*2.) WRITE(*,*)'   WARNING - At least one segmen
     +t is smaller than twice the wire radius'
C
C  Wire "location" of attachment point, NSA
      NSA(1) = 1
C  Plate number geometry is attached to, NPLA
      NPLA(1) = 1
C  Complex voltage generator, VGA
      VGA(1) = (1.0,0.0)
C  Outer disk radius of disk monopole (should be about .2lambda), BDSK
      BDSK(1) = 0.2*WV
C  No mutual coupling computations
c     NFS1=0
c     NFS2=0
C
      RETURN
      END
```