**Calculations of the Ratio of the Phase Speed of Fast Magnetosonic Waves to Alfven Wave Speed with Angle of Propagation in a Highly Gravitationally Stratified Solar Atmosphere**

**PHOTOSPHERE**

**LOWER PHOTOSPHERE**

**(1ST ITERATION)**

**(2ND ITERATION)**

**(3RD ITERATION)**

**(4TH ITERATION)**

**(5TH ITERATION)**

**SUMMARY OF RESULT IN THE LOWER PHOTOSPHERE**

|  |  |  |  |
| --- | --- | --- | --- |
| **S/N** | **Angle of Propagation (** |  |  |
| **1** | **0** | **99.9** |  |
| **2** | **45** |  |  |
| **3** | **90** | **0** | **0** |
| **4** | **135** |  |  |
| **5** | **180** | **99.9** |  |

**MID PHOTOSPHERE**

**(1ST ITERATION)**

**(2nd ITERATION)**

**(3rd ITERATION)**

**(4TH ITERATION)**

**(5TH ITERATION)**

**SUMMARY OF RESULT IN THE MID PHOTOSPHERE**

|  |  |  |  |
| --- | --- | --- | --- |
| **S/N** | **Angle of Propagation (** |  |  |
| **1** | **0** |  |  |
| **2** | **45** |  |  |
| **3** | **90** | **0** | **0** |
| **4** | **135** |  |  |
| **5** | **180** | **43.1** |  |

**UPPER PHOTOSPHERE**

**(1ST ITERATION)**

**(2nd ITERATION)**

**(3rd ITERATION)**

**(4th ITERATION)**

**(5th ITERATION)**

**SUMMARY OF RESULT IN THE UPPER PHOTOSPHERE**

|  |  |  |  |
| --- | --- | --- | --- |
| **S/N** | **Angle of Propagation (** |  |  |
| **1** | **0** |  |  |
| **2** | **45** |  |  |
| **3** | **90** | **0** | **0** |
| **4** | **135** |  |  |
| **5** | **180** | **37.2** |  |

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| LOWER PHOTOSPHERE | | | MID PHOTOSPHERE | | UPPER PHOTOSPHERE | |
| ( |  |  |  |  |  |  |
| 0 |  |  |  |  |  |  |
| 45 |  |  |  |  |  |  |
| 90 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| 135 |  |  |  |  |  |  |
| 180 |  |  |  |  |  |  |

**CHROMOSPHERE**

**LOWER CHROMOSPHERE**

**(1ST ITERATION)**

**(2ND ITERATION)**

**(3RD ITERATION)**

**(4th ITERATION)**

**(5TH ITERATION)**

**SUMMARY OF RESULT IN THE lower chromoSPHERE**

|  |  |  |  |
| --- | --- | --- | --- |
| **S/N** | **Angle of Propagation (** |  |  |
| **1** | **0** | **99** |  |
| **2** | **45** |  |  |
| **3** | **90** | **0** | **0** |
| **4** | **135** |  |  |
| **5** | **180** | **99.2** |  |

**mid CHROMOSPHERE**

**(1ST ITERATION)**

**(2ND ITERATION)**

**(3RD ITERATION)**

**(4TH ITERATION)**

**(5TH ITERATION)**

**SUMMARY OF RESULT IN THE MID chromoSPHERE**

|  |  |  |  |
| --- | --- | --- | --- |
| **S/N** | **Angle of Propagation (** |  |  |
| **1** | **0** | **98** |  |
| **2** | **45** |  |  |
| **3** | **90** | **0** | **0** |
| **4** | **135** |  |  |
| **5** | **180** | **98.3** |  |

**UPPER CHROMOSPHERE**

**(1ST ITERATION)**

**(2ND ITERATION)**

**(3RD ITERATION)**

**(4TH ITERATION)**

**(5TH ITERATION)**

**SUMMARY OF RESULT IN THE UPPER chromoSPHERE**

|  |  |  |  |
| --- | --- | --- | --- |
| **S/N** | **Angle of Propagation (** |  |  |
| **1** | **0** | **3** |  |
| **2** | **45** |  |  |
| **3** | **90** | **0** | **0** |
| **4** | **135** |  |  |
| **5** | **180** | **3.02** |  |

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **LOWER CHROMOSPHERE** | | | **MID CHROMOSPHERE** | | **UPPER CHROMOSPHERE** | |
| **(** |  |  |  |  |  |  |
| 0 |  |  |  |  |  |  |
| 45 |  |  |  |  |  |  |
| 90 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| 135 |  |  |  |  |  |  |
| 180 |  |  |  |  |  |  |

**CORONA**

**LOWER CORONA**

**(1ST ITERATION)**

**(2ND ITERATION)**

**(3RD ITERATION)**

**(4TH ITERATION)**

**(5TH ITERATION)**

**SUMMARY OF RESULT IN THE LOWER CORONA**

|  |  |  |  |
| --- | --- | --- | --- |
| **S/N** | **Angle of Propagation (** |  |  |
| **1** | **0** | **4** |  |
| **2** | **45** |  |  |
| **3** | **90** | **0** | **0** |
| **4** | **135** |  |  |
| **5** | **180** | **4.66** |  |

**MID CORONA**

**(1ST ITERATION)**

**(2ND ITERATION)**

**(3RD ITERATION)**

**(4TH ITERATION)**

**(5TH ITERATION)**

**SUMMARY OF RESULT IN THE MID CORONA**

|  |  |  |  |
| --- | --- | --- | --- |
| **S/N** | **Angle of Propagation (** |  |  |
| **1** | **0** | **2.89** |  |
| **2** | **45** |  |  |
| **3** | **90** | **0** | **0** |
| **4** | **135** |  |  |
| **5** | **180** | **2.89** |  |

**UPPER CORONA**

**(1ST ITERATION)**

**(2ND ITERATION)**

**(3RD ITERATION)**

**0m/s**

**(4TH ITERATION)**

**(5TH ITERATION)**

**SUMMARY OF RESULT IN THE UPPER CORONA**

|  |  |  |  |
| --- | --- | --- | --- |
| **S/N** | **Angle of Propagation (** |  |  |
| **1** | **0** | **2.60** |  |
| **2** | **45** |  |  |
| **3** | **90** | **0** | **0** |
| **4** | **135** |  |  |
| **5** | **180** | **2.60** |  |

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **LOWER CORONA** | | | **MID CORONA** | | **UPPER CORONA** | |
| **(** |  |  |  |  |  |  |
| 0 |  |  |  |  |  |  |
| 45 |  |  |  |  |  |  |
| 90 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| 135 |  |  |  |  |  |  |
| 180 |  |  |  |  |  |  |

**CALCULATION OF GROUP VELOCITY OF ALFVEN WAVE WITH EQUILIBRIUM MASS DENSITY**

**PHOTOSPHERE**

**LOWER PHOTOSPHERE**

**1ST ITERATION**

**= 69442435.14m/s = 6.9**

**=**

**= 34721217.57m/s = 3.5**

**2ND ITERATION**

**= 138884870.3m/s =** **1.4**

**69442435.15m/s = 6.9**

**3RD ITERATION**

**=**

**= 208327305.4m/s = 2.1**

**=**

**= 104163652.7m/s = 1.0**

**4TH ITERATION**

**=**

**= 277769740.6m/s = 2.8**

**=**

**= 138884870.3m/s = 1.4**

**5TH ITERATION**

**= 347212175.7m/s = 3.5**

**=**

**= 173606087.9m/s = 1.7**

**SUMMARY OF RESULT IN LOWER PHOTOSPHERE**

|  |  |  |  |
| --- | --- | --- | --- |
|  | |  | |
|  | **)** |  | **)** |
| **100.0** |  | **100.0** |  |
| **200.0** | **1.4** | **200.0** |  |
| **300.0** | **2.1** | **300.0** |  |
| **400.0** |  | **400.0** |  |
| **500.0** |  | **500.0** |  |

**PHOTOSPHERE**

**mid PHOTOSPHERE**

**1ST ITERATION**

**=**

**= 75388117.04m/s = 7.5**

**= 37694058.52m/s = 3.8**

**2ND ITERATION**

**=**

**= 245011380.4m/s = 2.5**

**= 122505690.2m/s = 1.2**

**3RD ITERATION**

**=**

**= 414634643.7m/s = 4.1**

**= 207317321.9m/s = 2.1**

**4TH ITERATION**

**= 584257907.1m/s = 5.8**

**= 292128953.6m/s = 2.9**

**5TH ITERATION**

**= 753881170.4m/s = 7.5**

**= 376940585.2m/s = 3.8**

**SUMMARY OF RESULT IN MID PHOTOSPHERE**

|  |  |  |  |
| --- | --- | --- | --- |
|  | |  | |
|  | **)** |  | **)** |
| **10.0** |  | **10.0** | **3.8** |
| **32.5** |  | **32.5** | **1.2** |
| **55.0** | **4.1** | **55.0** | **2.1** |
| **77.5** | **5.8** | **77.5** | **2.9** |
| **100.0** |  | **100.0** | **3.8** |

**PHOTOSPHERE**

**UPPER PHOTOSPHERE**

**1ST ITERATION**

**= 380351.8818m/s = 3.8**

**= 190175.9409m/s = 1.9**

**2ND ITERATION**

**= 1236143.615m/s = 1.2**

**= 618071.8075m/s = 6.2**

**3RD ITERATION**

**= 2091935.349m/s = 2.1**

**= 1045967.675m/s = 1.0**

**4TH ITERATION**

**= 2947727.083m/s = 2.9**

**= 1473863.542m/s = 1.5**

**5THITERATION**

**= 3803518.817m/s = 3.8**

**= 1901759.409m/s = 1.9**

**SUMMARY OF RESULT IN UPPER PHOTOSPHERE**

|  |  |  |  |
| --- | --- | --- | --- |
|  | |  | |
|  | **)** |  | **)** |
| **1.0** |  | **1.0** |  |
| **3.25** |  | **3.25** |  |
| **5.5** |  | **5.5** |  |
| **7.75** |  | **7.75** |  |
| **10.0** |  | **10.0** |  |

**GENERAL SUMMARY**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  | **LOWER PHOTOSPHERE** | | **MID PHOTOSPHERE** | | **UPPER PHOTOSPHERE** | |
|  | **)** | **)** | **)** | **)** | **)** | **)** |
| **1.0** |  |  |  |  |  |  |
| **3.25** |  |  |  |  |  |  |
| **5.5** |  |  |  |  |  |  |
| **7.75** |  |  |  |  |  |  |
| **10.0** |  |  |  |  |  |  |

**CHROMOSPHERE**

**LOWER CHROMOSPHERE**

**1ST ITERATION**

**= 46062900.38m/s = 4.6**

**= 23031450.19m/s = 2.3**

**2ND ITERATION**

**= 149704426.2m/s = 1.5**

**= 74852213.11m/s = 7.5**

**3RD ITERATION**

**= 253345952.1m/s = 2.5**

**= 126672976m/s = 1.3**

**4TH ITERATION**

**= 356987477.9m/s = 3.6**

**= 178493739m/s = 1.8**

**5TH ITERATION**

**= 460629003.8m/s = 4.6**

**= 230314501.9m/s = 2.3**

**SUMMARY OF RESULT IN LOWER CHROMOSPHERE**

|  |  |  |  |
| --- | --- | --- | --- |
|  | |  | |
|  | **)** |  | **)** |
| **1.0** |  | **1.0** |  |
| **3.25** |  | **3.25** |  |
| **5.5** |  | **5.5** |  |
| **7.75** |  | **7.75** |  |
| **10.0** |  | **10.0** |  |

**CHROMOSPHERE**

**MID CHROMOSPHERE**

**1ST ITERATION**

**= 18805100.34m/s = 1.9**

**= 9402550.168m/s = 9.4**

**2ND ITERATION**

**= 61116576.09m/s = 6.1**

**= 30558288.05m/s = 3.1**

**3RD ITERATION**

**= 103428051.8m/s = 1.0**

**= 51714025.92m/s = 5.2**

**4TH ITERATION**

**= 145739527.6m/s = 1.5**

**= 72869763.8m/s = 7.3**

**5TH ITERATION**

**= 188051003.4m/s = 1.9**

**= 94025501.68m/s = 9.4**

**SUMMARY OF RESULT IN MID CHROMOSPHERE**

|  |  |  |  |
| --- | --- | --- | --- |
|  | |  | |
|  | **)** |  | **)** |
| **0.1** |  | **0.1** |  |
| **0.325** |  | **0.325** |  |
| **0.55** |  | **0.55** |  |
| **0.775** |  | **0.775** |  |
| **1.0** |  | **1.0** |  |

**CHROMOSPHERE**

**UPPER CHROMOSPHERE**

**1ST ITERATION**

**= 3257138.922m/s = 3.3**

**= 1628569.461m/s = 1.6**

**2ND ITERATION**

**= 10585701.5m/s = 1.1**

**= 15292850.748m/s = 5.3**

**3RD ITERATION**

**= 17914264.07m/s = 1.8**

**= 8957132.035m/s = 8.9**

**4TH ITERATION**

**= 25242826.64m/s = 2.5**

**= 12621413.32m/s = 1.3**

**5TH ITERATION**

**= 32571389.22m/s = 3.3**

**= 16285694.61m/s = 1.6**

**SUMMARY OF RESULT IN UPPER CHROMOSPHERE**

|  |  |  |  |
| --- | --- | --- | --- |
|  | |  | |
|  | **)** |  | **)** |
| **0.01** |  | **0.01** |  |
| **0.0325** |  | **0.0325** |  |
| **0.055** |  | **0.055** |  |
| **0.0775** |  | **0.0775** |  |
| **0.1** |  | **0.1** |  |

**GENERAL SUMMARY**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  | **LOWER CHROMOSPHERE** | | **MID CHROMOSPHERE** | | **UPPER CHROMOSPHERE** | |
|  | **)** | **)** | **)** | **)** | **)** | **)** |
| **0.0100** |  |  |  |  |  |  |
| **0.0325** |  |  |  |  |  |  |
| **0.0550** |  |  |  |  |  |  |
| **0.0775** |  |  |  |  |  |  |
| **0.1000** |  |  |  |  |  |  |

**CORONA**

**LOWER CORONA**

**1ST ITERATION**

**= 1628569.461m/s = 1.6**

**= 814284.7305m/s = 8.1**

**2ND ITERATION**

**= 5292850.748m/s = 5.3**

**= 2646425.374m/s = 2.6**

**3RD ITERATION**

**= 8957132.035m/s = 8.9**

**= 4478566.018m/s = 4.5**

**4TH ITERATION**

**= 12621413.32m/s = 1.3**

**= 6310706.66m/s = 6.3**

**5TH ITERATION**

**= 16285694.61m/s = 1.6**

**= 8142847.305m/s = 8.1**

**SUMMARY OF RESULT IN LOWER CORONA**

|  |  |  |  |
| --- | --- | --- | --- |
|  | |  | |
|  | **)** |  | **)** |
| **0.001** |  | **0.001** |  |
| **0.00325** |  | **0.00325** |  |
| **0.0055** |  | **0.0055** |  |
| **0.00775** |  | **0.00775** |  |
| **0.01** |  | **0.01** |  |

**mid CORONA**

**1ST ITERATION**

**= 252296.896m/s = 2.5**

**= 126148.448m/s = 1.3**

**2ND ITERATION**

**= 819964.912m/s = 8.2**

**= 409982.456m/s = 4.1**

**3RD ITERATION**

**= 1387632.928m/s = 1.4**

**= 693816.464m/s = 6.9**

**4TH ITERATION**

**= 1955300.944m/s = 1.9**

**= 977650.472m/s = 9.8**

**5TH ITERATION**

**= 2522968.96m/s = 2.5**

**= 1261484.48m/s = 1.3**

**SUMMARY OF RESULT IN MID CORONA**

|  |  |  |  |
| --- | --- | --- | --- |
|  | |  | |
|  | **)** |  | **)** |
| **0.0001** |  | **0.0001** |  |
| **0.000325** |  | **0.000325** |  |
| **0.00055** |  | **0.00055** |  |
| **0.000775** |  | **0.000775** |  |
| **0.001** |  | **0.001** |  |

**UPPER CORONA**

**1ST ITERATION**

**= 162856.9461m/s = 1.6**

**= 81428.47305m/s = 8.1**

**2ND ITERATION**

**= 529285.0748m/s = 5.3**

**= 264642.5374m/s = 2.6**

**3RD ITERATION**

**= 895713.2035m/s = 8.9**

**= 447856.6018m/s = 4.5**

**4TH ITERATION**

**= 1262141.332m/s = 1.3**

**= 1262141.332m/s = 6.3**

**5TH ITERATION**

**= 1628569.461m/s = 1.6**

**= 814284.7305m/s = 8.1**

**SUMMARY OF RESULT IN UPPER CORONA**

|  |  |  |  |
| --- | --- | --- | --- |
|  | |  | |
|  | **)** |  | **)** |
| **0.00001** |  | **0.00001** |  |
| **0.0000325** |  | **0.0000325** |  |
| **0.000055** |  | **0.000055** |  |
| **0.0000775** |  | **0.0000775** |  |
| **0.0001** |  | **0.0001** |  |

**GENERAL SUMMARY**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  | **LOWER CORONA** | | **MID CORONA** | | **UPPER CORONA** | |
|  | **)** | **)** | **)** | **)** | **)** | **)** |
| **0.00001** |  |  |  |  |  |  |
| **0.0000325** |  |  |  |  |  |  |
| **0.0000550** |  |  |  |  |  |  |
| **0.0000775** |  |  |  |  |  |  |
| **0.0001** |  |  |  |  |  |  |

**CALCULATION OF TAN OF PROPAGATION ANGLE WITH PERIOD OF OSCILLATION OF ALFVEN WAVE**

**Where**

**LOWER PHOTOSPHERE**

**T = 5 – 12seconds**

**1ST ITERATION**

**2ND ITERATION**

**T = 6.75seconds**

**3RD ITERATION**

**T = 8.5seconds**

**4TH ITERATION**

**T = 10.25seconds**

**5TH ITERATION**

**T = 12seconds**

**MID PHOTOSPHERE**

**T = 5 - 12seconds**

**1ST ITERATION**

**2ND ITERATION**

**3RD ITERATION**

**4TH ITERATION**

**5TH ITERATION**

**UPPER PHOTOSPHERE**

**T = 5 - 12seconds**

**1ST ITERATION**

**2ND ITERATION**

**3RD ITERATION**

**4TH ITERATION**

**5TH ITERATION**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  | **LOWER PHOTOSPHERE** | | **MID PHOTOSPHERE** | | **UPPER PHOTOSPHERE** | |
| **T(s)** |  |  |  |  |  |  |
| **5.0** |  | **9.91** |  | **40.3** |  | **25.3** |
| **6.75** |  | **22.3** |  | **11.3** |  | **6.32** |
| **8.5** |  | **15.8** |  | **7.81** |  | **4.37** |
| **10.25** |  | **13.2** |  | **6.51** |  | **3.64** |
| **12.0** |  | **11.8** |  | **6.16** |  | **3.25** |

**CHROMOSPHERE**

**LOWER CHROMOSPHERE**

**T = 5 – 12seconds**

**1ST ITERATION**

**2ND ITERATION**

**3RD ITERATION**

**4TH ITERATION**

**5TH ITERATION**

**SUMMARY OF LOWER CHROMOSPHERE**

|  |  |  |  |
| --- | --- | --- | --- |
| **S/N** | **T(s)** |  |  |
| **1** | **5.0** |  | **89.9** |
| **2** | **6.75** |  | **22.3** |
| **3** | **8.5** |  | **15.8** |
| **4** | **10.25** |  | **13.3** |
| **5** | **12.0** |  | **11.9** |

**MID CHROMOSPHERE**

**T = 5 – 12seconds**

**1ST ITERATION**

**2ND ITERATION**

**3RD ITERATION**

**4TH ITERATION**

**5TH ITERATION**

**SUMMARY OF MID CHROMOSPHERE**

|  |  |  |  |
| --- | --- | --- | --- |
| **S/N** | **T(s)** |  |  |
| **1** | **5.0** |  | **10.9** |
| **2** | **6.75** |  | **2.59** |
| **3** | **8.5** |  | **1.79** |
| **4** | **10.25** |  | **1.49** |
| **5** | **12.0** |  | **1.33** |

**UPPER CHROMOSPHERE**

**T = 5 – 12seconds**

**1ST ITERATION**

**2ND ITERATION**

**3RD ITERATION**

**4TH ITERATION**

**5TH ITERATION**

**SUMMARY OF UPPER CHROMOSPHERE**

|  |  |  |  |
| --- | --- | --- | --- |
| **S/N** | **T(s)** |  |  |
| **1** | **5.0** |  | **20.1** |
| **2** | **6.75** |  | **4.89** |
| **3** | **8.5** |  |  |
| **4** | **10.25** |  | **2.82** |
| **5** | **12.0** |  | **2.51** |

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  | **LOWER CHROMOSPHERE** | | **MID CHROMOSPHERE** | | **UPPER CHROMOSPHERE** | |
| **T(s)** |  |  |  |  |  |  |
| **5.0** |  | **89.9** |  | **10.9** |  | **20.1** |
| **6.75** |  |  |  |  |  | **4.89** |
| **8.5** |  | **15.8** |  |  |  | **3.38** |
| **10.25** |  | **13.3** |  |  |  | **2.82** |
| **12.0** |  | **11.9** |  |  |  | **2.51** |

**LOWER CORONA**

**T = 5 – 12seconds**

**1ST ITERATION**

**2ND ITERATION**

**3RD ITERATION**

**4TH ITERATION**

**5TH ITERATION**

**SUMMARY OF LOWER CORONA**

|  |  |  |  |
| --- | --- | --- | --- |
| **S/N** | **T(s)** |  |  |
| **1** | **5.0** |  | **86.7** |
| **2** | **6.75** |  | **76.1** |
| **3** | **8.5** |  | **70.3** |
| **4** | **10.25** |  | **66.7** |
| **5** | **12.0** |  | **64.3** |

**MID CORONA**

**T = 5 – 12seconds**

**1ST ITERATION**

**2ND ITERATION**

**3rd ITERATION**

**4th ITERATION**

**5th ITERATION**

**SUMMARY OF MID CORONA**

|  |  |  |  |
| --- | --- | --- | --- |
| **S/N** | **T(s)** |  |  |
| **1** | **5.0** |  | **89.9** |
| **2** | **6.75** |  | **89.7** |
| **3** | **8.5** |  | **89.5** |
| **4** | **10.25** |  | **89.5** |
| **5** | **12.0** |  | **89.5** |

**UPPER CORONA**

**T = 5 – 12seconds**

**1ST ITERATION**

**2nd ITERATION**

**3rd ITERATION**

**4th ITERATION**

**5th ITERATION**

**SUMMARY OF UPPER CORONA**

|  |  |  |  |
| --- | --- | --- | --- |
| **S/N** | **T(s)** |  |  |
| **1** | **5.0** |  | **89.9** |
| **2** | **6.75** |  | **89.8** |
| **3** | **8.5** |  | **89.8** |
| **4** | **10.25** |  | **89.7** |
| **5** | **12.0** |  | **89.6** |

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  | **LOWER CORONA** | | **MID CORONA** | | **UPPER CORONA** | |
| **T(s)** |  |  |  |  |  |  |
| **5.0** |  | **89.7** |  | **89.9** |  | **89.9** |
| **6.75** |  | **76.1** |  | **89.7** |  | **89.8** |
| **8.5** |  | **70.3** |  | **89.5** |  | **89.8** |
| **10.25** |  | **66.7** |  | **89.5** |  | **89.7** |
| **12.0** |  | **64.3** |  | **89.5** |  | **89.6** |