In [2]:
```python
import pandas as pd
import numpy as np
import matplotlib.pyplot as plt
import warnings
warnings.filterwarnings('ignore')
import yfinance as yf
```

In [48]:
```python
# Extraccioón de datos historicos con un rango especifico

dis = yf.download(tickers = 'DIS', start = '2023-01-01', end = '2023-04-01', rounding = True)
dis.columns = dis.columns.droplevel(1)
dis.index = pd.to_datetime(dis.index).strftime('%Y-%m-%d')
dis
```

```
[*********************100%***********************]  1 of 1 completed
```

Out[48]:

Price	Adj Close	Close	High	Low	Open	Volume
Date						
2023-01-03	88.27	88.97	89.97	87.83	88.98	14997100
2023-01-04	91.26	91.98	92.75	89.36	90.00	14957200
2023-01-05	91.20	91.92	92.48	90.51	91.66	11622600
2023-01-06	93.18	93.92	94.69	91.32	92.66	9828100
2023-01-09	94.03	94.77	95.70	93.45	94.43	11675800
...	...	...	...	...	...	...
2023-03-27	94.87	95.62	96.02	94.38	94.78	7487900
2023-03-28	94.08	94.82	96.00	94.59	95.51	5426100
2023-03-29	96.11	96.87	96.91	95.35	96.08	5889100
2023-03-30	97.33	98.10	98.92	97.67	98.73	7669500
2023-03-31	99.35	100.13	100.20	98.50	98.89	8920000

In [49]:
```python
dis = dis['Close']
dis
```

Out[49]:
```
Date
2023-01-03     88.97
2023-01-04     91.98
2023-01-05     91.92
2023-01-06     93.92
2023-01-09     94.77
               ...
2023-03-27     95.62
2023-03-28     94.82
2023-03-29     96.87
2023-03-30     98.10
2023-03-31    100.13
Name: Close, Length: 62, dtype: float64
```

In [50]:
```python
# utilizamos el 70% de la base para la base de entrenamiento
dis.index = pd.to_datetime(dis.index)
len_train = int(len(dis)* .7)
len_train
```

Out[50]: 43

In [51]:
```python
# utilizamos el 30% de la base para la base de pruebas

len_test = int(len(dis) * .3)
len_test
```

Out[51]: 18

In [52]:
```
# definimos grupos de puerba y entrenamiento
train = dis[0:len_train]
train
```

Out[52]:
```
Date
2023-01-03     88.97
2023-01-04     91.98
2023-01-05     91.92
2023-01-06     93.92
2023-01-09     94.77
2023-01-10     95.56
2023-01-11     96.33
2023-01-12     99.81
2023-01-13     99.40
2023-01-17     99.91
2023-01-18     99.04
2023-01-19     99.08
2023-01-20    103.48
```

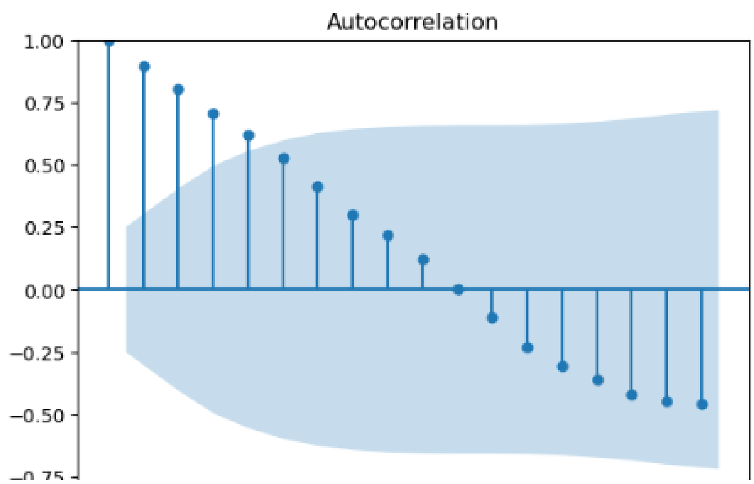
In [53]:
```
test = dis[len_train:]
test
```

Out[53]:
```
Date
2023-03-07     99.06
2023-03-08     99.30
2023-03-09     96.14
2023-03-10     93.57
2023-03-13     92.60
2023-03-14     93.36
2023-03-15     93.10
2023-03-16     94.29
2023-03-17     93.20
2023-03-20     94.22
2023-03-21     96.54
2023-03-22     94.90
2023-03-23     95.83
2023-03-24     94.08
2023-03-27     95.62
2023-03-28     94.82
2023-03-29     96.87
2023-03-30     98.10
2023-03-31    100.13
Name: Close, dtype: float64
```

In [54]:

```python
# obtenemos los valores para la grafica de autocorrelacion, funcion de autorcorrelacion(acf)

from statsmodels.tsa.stattools import acf
from statsmodels.graphics.tsaplots import plot_acf

acf_array = acf(train)
print(acf_array)

# grafico de nivel de confianza del 90%

plot_acf(train, alpha = 0.10)
plt.show()
```

```
[ 1.00000000e+00  8.93676862e-01  8.05243892e-01  7.06909430e-01
  6.22030380e-01  5.25234900e-01  4.15450780e-01  3.00150124e-01
  2.19430750e-01  1.20838146e-01  4.18616085e-04 -1.11289565e-01
 -2.28961906e-01 -3.03417271e-01 -3.62183951e-01 -4.20839262e-01
 -4.48296465e-01]
```



In [55]:

```python
# hacemos el ajuste con ARIMA
from statsmodels.tsa.arima.model import ARIMA

model = ARIMA(train, order = (1,0,0))
result = model.fit()
```

```
C:\Users\Isaac\anaconda3\Lib\site-packages\statsmodels\tsa\base\tsa_model.py:473: ValueWarnin
but it has no associated frequency information and so will be ignored when e.g. forecasting.
  self._init_dates(dates, freq)
C:\Users\Isaac\anaconda3\Lib\site-packages\statsmodels\tsa\base\tsa_model.py:473: ValueWarnin
but it has no associated frequency information and so will be ignored when e.g. forecasting.
  self._init_dates(dates, freq)
C:\Users\Isaac\anaconda3\Lib\site-packages\statsmodels\tsa\base\tsa_model.py:473: ValueWarnin
but it has no associated frequency information and so will be ignored when e.g. forecasting.
  self._init_dates(dates, freq)
```

In [56]:

```python
print(result.summary())
```

```
                               SARIMAX Results
==============================================================================
Dep. Variable:                  Close   No. Observations:                   43
Model:                 ARIMA(1, 0, 0)   Log Likelihood                 -86.541
Date:                Wed, 06 Nov 2024   AIC                            179.083
Time:                        14:00:17   BIC                            184.367
Sample:                             0   HQIC                           181.031
                                 - 43
Covariance Type:                  opg
==============================================================================
                 coef    std err          z      P>|z|      [0.025      0.975]
------------------------------------------------------------------------------
const         98.0216      5.257     18.645      0.000      87.717     108.326
ar.L1          0.9717      0.031     30.960      0.000       0.910       1.033
sigma2         3.0655      0.663      4.624      0.000       1.766       4.365
===================================================================================
Ljung-Box (L1) (Q):                   0.03   Jarque-Bera (JB):                 0.56
Prob(Q):                              0.87   Prob(JB):                         0.76
Heteroskedasticity (H):               0.56   Skew:                             0.27
Prob(H) (two-sided):                  0.28   Kurtosis:                         2.88
===================================================================================
```

In [57]:
```
# realizamos las predicciones

predicciones = result.forecast(len(test))
predicciones
```

```
C:\Users\Isaac\anaconda3\Lib\site-packages\statsmodels\tsa\base\tsa_m
e. Prediction results will be given with an integer index beginning a
  return get_prediction_index(
```

Out[57]:
```
43    100.585304
44    100.512722
45    100.442195
46    100.373665
47    100.307075
48    100.242371
```

In [59]:
```
# pronosticamos con un intervalode confianza de 90%
conf = result.get_forecast(len(test)).conf_int(alpha = .10)
conf
```

```
C:\Users\Isaac\anaconda3\Lib\site-packages\statsmodels\tsa\base\tsa
e. Prediction results will be given with an integer index beginning
  return get_prediction_index(
```

Out[59]:

	lower Close	upper Close
43	97.705423	103.465184
44	96.497195	104.528249
45	95.592651	105.291740
46	94.851077	105.896254
47	94.216903	106.397248
48	93.661072	106.823669
49	93.165983	107.193013

```
In [60]: fcast_result = result.get_forecast(len(test))
         print(fcast_result.summary_frame(alpha = .10))
```

```
Close        mean   mean_se  mean_ci_lower  mean_ci_upper
43     100.585304  1.750843      97.705423     103.465184
44     100.512722  2.441267      96.497195     104.528249
45     100.442195  2.948314      95.592651     105.291740
46     100.373665  3.357495      94.851077     105.896254
47     100.307075  3.702562      94.216903     106.397248
48     100.242371  4.001145      93.661072     106.823669
49     100.179498  4.263914      93.165983     107.193013
50     100.118405  4.497947      92.719940     107.516870
51     100.059042  4.708251      92.314658     107.803426
52     100.001360  4.898536      91.943984     108.058735
53      99.945310  5.071651      91.603187     108.287433
54      99.890848  5.229845      91.288519     108.493177
55      99.837927  5.374937      90.996943     108.678911
56      99.786505  5.508423      90.725956     108.847054
57      99.736538  5.631554      90.473456     108.999620
58      99.687986  5.745391      90.237659     109.138313
59      99.640809  5.850840      90.017033     109.264585
60      99.594967  5.948688      89.810246     109.379688
61      99.550423  6.039619      89.616134     109.484713
```

```
C:\Users\Isaac\anaconda3\Lib\site-packages\statsmodels\tsa\base\tsa_model.py:836: ValueWarning: No suppor
e. Prediction results will be given with an integer index beginning at `start`.
  return get_prediction_index(
```

```
In [61]: # Convertimos test a DataFrame
         test = pd.DataFrame(test)
         test = test.reset_index()
```

```
In [62]: # Convertimos test a DataFrame
         predicciones = pd.DataFrame(predicciones)
         predicciones = predicciones.reset_index()
```

```
In [73]: test
```

Out[73]:

	Date	Close
0	2023-03-07	99.06
1	2023-03-08	99.30
2	2023-03-09	96.14
3	2023-03-10	93.57
4	2023-03-13	92.60
5	2023-03-14	93.36
6	2023-03-15	93.10
7	2023-03-16	94.29
8	2023-03-17	93.20

In [72]:
```python
predicciones
```

Out[72]:

	index	predicted_mean
0	43	100.585304
1	44	100.512722
2	45	100.442195
3	46	100.373665
4	47	100.307075
5	48	100.242371
6	49	100.179498
7	50	100.118406

In [71]:
```python
# calculamos el nivel de error cuando comparamos las predicciones con los valores de test

acumulador1 = 0
acumulador2 = 0

for contador in range(0, 18):
    acumulador1 = acumulador1 + (test.iloc[contador][1] - predicciones.iloc[contador][1]) ** 2
    acumulador2 = acumulador2 + np.abs((test.iloc[contador][1] - predicciones.iloc[contador][1]) / test.iloc[contador][1])

mse = acumulador1 / 18
rmse = np.round(np.sqrt(mse), 2)
mape = np.round((acumulador2 / 18) * 100, 2)
print('RSEM =', rmse, 'Mape =', mape, '%')
```

```
RSEM = 5.14 Mape = 5.02 %
```

In [74]:
```python
# Tambien podemos usar sklearn y obtendriamos resultados parecidos

from sklearn.metrics import mean_squared_error

# RMSE
rmse = np.round(np.sqrt(mean_squared_error(test['Close'], predicciones['predicted_mean'])), 2)

# MAPE
mape = np.round(np.mean(np.abs((test['Close'] - predicciones['predicted_mean']) / test['Close'])) * 100, 2)

print('RMSE =', rmse, 'Mape =', mape, '%')
```

```
RMSE = 5.0 Mape = 4.79 %
```

*** La desvacion media absoluta porcentual es de Mape = 5.0 %, y en promedio nos equivocamos 4.79 dlls al pronosticar**

Pronostica los precios diarios por acción para el mes de Abril del 2023, tanto de manera puntual como mediante un intervalo de confianza del 90%, a partir del resultado obtenido en el punto anterior, p.

In [76]:
```python
# pronostico para el mes de abril

predicciones = result.forecast(len(test) + 30)
predicciones.tail(30)
```

```
C:\Users\Isaac\anaconda3\Lib\site-packages\statsmodels\tsa\base\tsa_model.py:836: ValueWarning: No supported index is availabl
e. Prediction results will be given with an integer index beginning at `start`.
  return get_prediction_index(
```

Out[76]:
```
62    99.507141
63    99.465083
64    99.424217
65    99.384507
66    99.345922
67    99.308429
68    99.271997
69    99.236597
70    99.202199
71    99.168775
72    99.136297
73    99.104739
74    99.074074
75    99.044278
76    99.015325
77    98.987191
78    98.959854
79    98.933292
80    98.907481
81    98.882401
```

In [77]:
```python
# realizamos un pronostico con intervalode confianza del 90%

conf = result.get_forecast(len(test) + 30).conf_int(alpha = 0.10)
conf.tail(30)
```

```
C:\Users\Isaac\anaconda3\Lib\site-packages\statsmodels\tsa\base\tsa_model.py:836: ValueWarning: No
e. Prediction results will be given with an integer index beginning at `start`.
  return get_prediction_index(
```

Out[77]:

	lower Close	upper Close
62	89.433670	109.580611
63	89.261943	109.668223
64	89.100140	109.748293
65	88.947531	109.821483
66	88.803458	109.888385
67	88.667326	109.949531
68	88.538593	110.005401
69	88.416767	110.056427
70	88.301396	110.103002
71	88.192067	110.145483
72	88.088400	110.184194

In [78]:
```
train = pd.DataFrame(train)
lista = test['Date']
lista = pd.DataFrame(lista)
test.index = test['Date']
test.drop(columns = ['Date'], inplace = True)
test
```

Out[78]:

	Close
Date	
2023-03-07	99.06
2023-03-08	99.30
2023-03-09	96.14
2023-03-10	93.57
2023-03-13	92.60
2023-03-14	93.36
2023-03-15	93.10
2023-03-16	94.29
2023-03-17	93.20

In [79]:
```
lista
```

Out[79]:

	Date
0	2023-03-07
1	2023-03-08
2	2023-03-09
3	2023-03-10
4	2023-03-13
5	2023-03-14
6	2023-03-15
7	2023-03-16
8	2023-03-17
9	2023-03-20
10	2023-03-21

In [86]:
```python
# generamos 30 dias poseteriores (mes de abril) de la ultima fecha '2023-03-31'

lista2 = []
for day in range(1, 21):
    fecha = ((pd.to_datetime('2023-03-31') + pd.offsets.BDay(day)).date())
    lista2.append(fecha)

# convertimos lista2 en DF

lista2 = pd.DataFrame(lista2, columns = ['Date'])
lista2['Date'] = pd.to_datetime(lista2['Date'])
lista2
```

Out[86]:

	Date
0	2023-04-03
1	2023-04-04
2	2023-04-05
3	2023-04-06
4	2023-04-07
5	2023-04-10
6	2023-04-11
7	2023-04-12
8	2023-04-13
9	2023-04-14

In [89]:
```python
lista3.drop(columns = ['index'], inplace = True)
lista3
```

Out[89]:

	Date
0	2023-03-07
1	2023-03-08
2	2023-03-09
3	2023-03-10
4	2023-03-13
5	2023-03-14
6	2023-03-15
7	2023-03-16
8	2023-03-17
9	2023-03-20
10	2023-03-21
11	2023-03-22
12	2023-03-23
13	2023-03-24
14	2023-03-27
15	2023-03-28

In [90]:

```python
# predcciones lo convertimos en DF, y reseteamos el indice

predicciones = pd.DataFrame(predicciones)
predicciones = predicciones.reset_index()

predicciones.drop(columns = ['index'], inplace = True)
predicciones
```

Out[90]:

	predicted_mean
0	100.585304
1	100.512722
2	100.442195
3	100.373665
4	100.307075
5	100.242371
6	100.179498
7	100.118405
8	100.059042

In [98]:

```python
# concatenamos lista3 con las predicciones

frames = [lista3, predicciones]
res = pd.concat(frames, axis = 1, join = 'inner')

# renombramos las columnas

res.columns = ['Date', 'Predicciones']
res
```

28	2023-04-14	[illegible]
29	2023-04-17	99.136297
30	2023-04-18	99.104739
31	2023-04-19	99.074074
32	2023-04-20	99.044278
33	2023-04-21	99.015325
34	2023-04-24	98.987191
35	2023-04-25	98.959854
36	2023-04-26	98.933292
37	2023-04-27	98.907481
38	2023-04-28	98.882401

```
In [100]: # dejamos como indice el campo 'Date'

          res.index = res['Date']
          res.drop(columns = ['Date'], inplace = True)
          res
```

2023-04-18	99.104739
2023-04-19	99.074074
2023-04-20	99.044278
2023-04-21	99.015325
2023-04-24	98.987191
2023-04-25	98.959854
2023-04-26	98.933292
2023-04-27	98.907481
2023-04-28	98.882401

```
In [101]: conf = conf.reset_index()
          conf.drop(columns = ['index'], inplace = True)
          conf
```

Out[101]:

	lower Close	upper Close
0	97.705423	103.465184
1	96.497195	104.528249
2	95.592651	105.291740
3	94.851077	105.896254
4	94.216903	106.397248
5	93.661072	106.823669

In [119]:
```
frames = [lista3, conf]
intervalos = pd.concat(frames, axis = 1, join = 'inner')
intervalos.tail(10)
```

Out[119]:

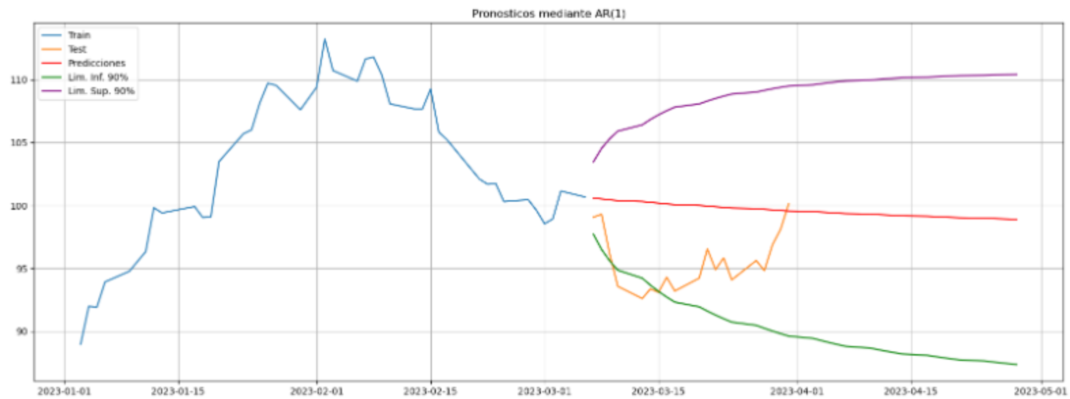
	Date	lower Close	upper Close
29	2023-04-17	88.088400	110.184194
30	2023-04-18	87.990046	110.219433
31	2023-04-19	87.896679	110.251469
32	2023-04-20	87.808002	110.280553
33	2023-04-21	87.723737	110.306912
34	2023-04-24	87.643627	110.330755
35	2023-04-25	87.567433	110.352276
36	2023-04-26	87.494931	110.371652
37	2023-04-27	87.425915	110.389047
38	2023-04-28	87.360189	110.404612

In [120]:
```
intervalos.index = intervalos['Date']
intervalos.drop(columns = ['Date'], inplace = True)
intervalos.tail(15)
```

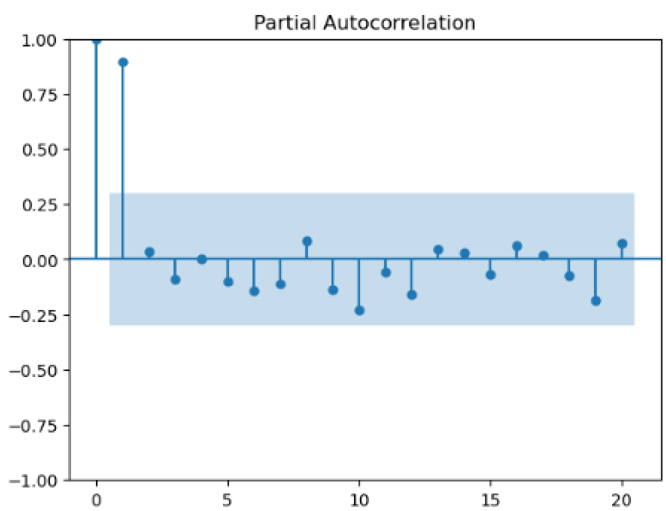
Out[120]:

	lower Close	upper Close
Date		
2023-04-10	88.667326	109.949531
2023-04-11	88.538593	110.005401
2023-04-12	88.416767	110.056427
2023-04-13	88.301396	110.103002
2023-04-14	88.192067	110.145483
2023-04-17	88.088400	110.184194
2023-04-18	87.990046	110.219433
2023-04-19	87.896679	110.251469
2023-04-20	87.808002	110.280553
2023-04-21	87.723737	110.306912
2023-04-24	87.643627	110.330755
2023-04-25	87.567433	110.352276
2023-04-26	87.494931	110.371652
2023-04-27	87.425915	110.389047
2023-04-28	87.360189	110.404612

In [106]:
```
# gráficamos

plt.figure(figsize = (20,7))
plt.grid()
plt.plot(train, label = 'Train')
plt.plot(test, label = 'Test')
plt.plot(res, label = 'Predicciones', color = 'red')
plt.plot(intervalos['lower Close'], label = 'Lim. Inf. 90%', color = 'green')
plt.plot(intervalos['upper Close'], label = 'Lim. Sup. 90%', color = 'purple')
plt.legend()
plt.title('Pronosticos mediante AR(1)')
plt.show()
```

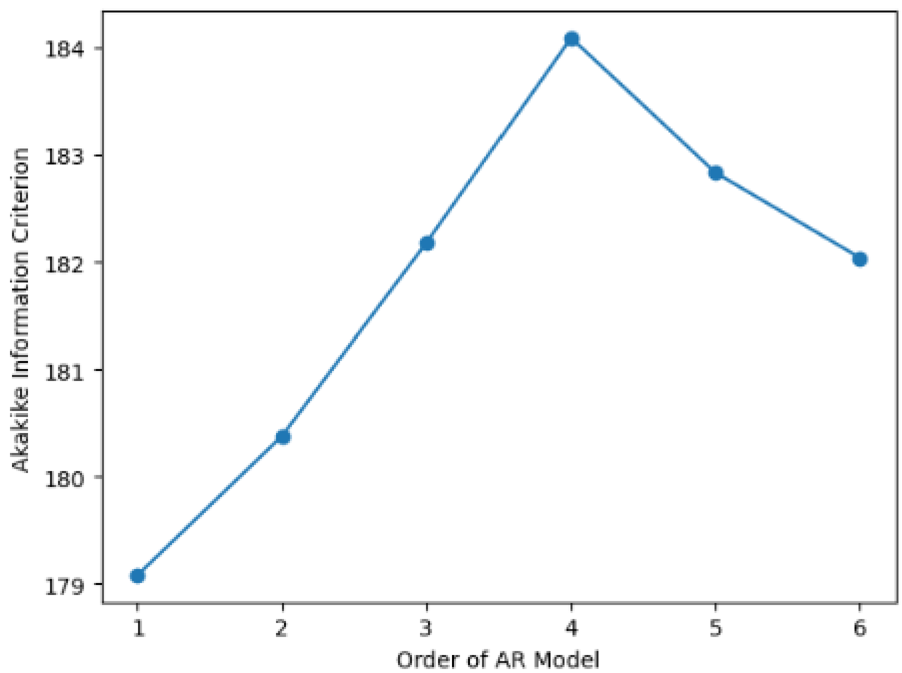


In [113]:
```
# Determinación del valor adecuado de p para AR(1) a partir de la función de autocorrelación parcial

from statsmodels.graphics.tsaplots import plot_pacf
plot_pacf(train, lags = 20)
plt.show()
```



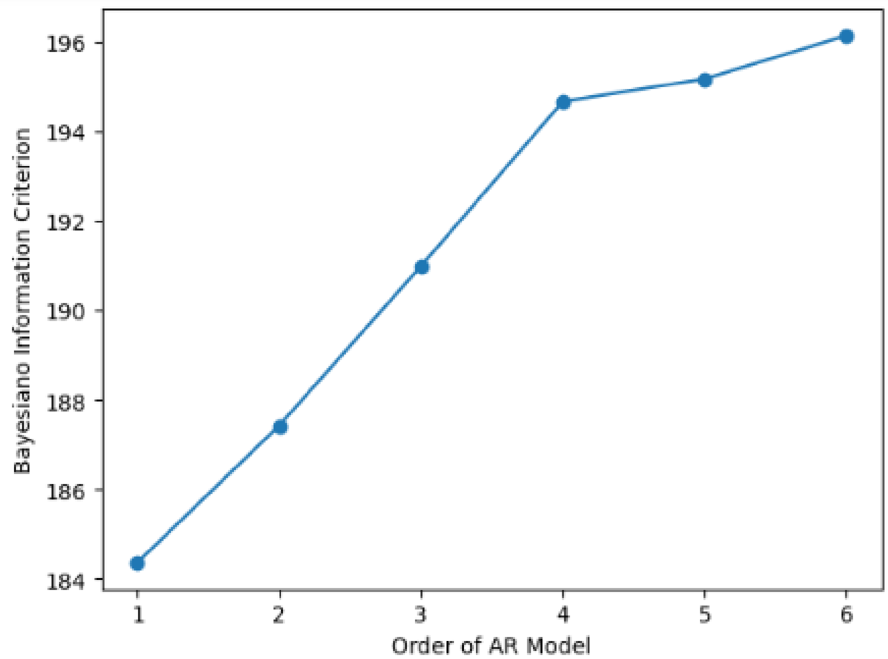
* **Conclusión: El modelo AR(1) parace ser el mas adecuado**

In [117]:
```
# Determinación del valor adecuado de p para AR(p), a partir del criterio de de información Akaike
# fit the data to an AR(p) for p = 0,...,6 and save the BIC

AIC = np.zeros(7)
for p in range(7):
    model = ARIMA(train, order = (p,0,0))
    result = model.fit()

# save the BIC for AR(p)
    AIC[p] = result.aic

# graficamos

plt.plot(range(1,7), AIC[1:7], marker = 'o')
plt.xlabel('Order of AR Model')
plt.ylabel('Akakike Information Criterion')
plt.show()
```



In [118]:

```
# Determinación del valor adecuado de p para AR(p), a partir del criterio de de información Bayesiano
# fit the data to an AR(p) for p = 0,...,6 and save the BIC

BIC = np.zeros(7)
for p in range(7):
    mod = ARIMA(train, order = (p,0,0))
    res = mod.fit()

# save the BIC for AR(p)
    BIC[p] = res.bic

# Graficamos
plt.plot(range(1,7), BIC[1:7], marker = 'o')
plt.xlabel('Order of AR Model')
plt.ylabel('Bayesiano Information Criterion')
plt.show()
```



Conclusión: En ambos Indices se tiene el menor valor para p = 1.

- Se recomienda utilizar el modelo AR(1)